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花粉來源與雜交組合對暗玉米蛋白質、離胺酸及油分含量的影響[1]

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摘要：一、暗玉米單交種３種，雙交種３種，及普通玉米臺南11號，進行（i）自花授粉（ii）不同暗玉米品種花粉授粉（iii）普通玉米花粉授粉等三種處理，以明瞭花粉對暗玉米子粒化學成分改變的當代影響。結果花粉對油分含量而言，三種處理間均無顯著差異。而蛋白質及離胺酸之含量，如自花授粉或以不同暗玉米品種花粉授粉者，兩者間無顯著差異。而普通玉米花粉對暗玉米蛋白質及離胺酸含量均顯示：花粉直感效應使暗玉米之此二種成分減低至和普通玉米相近。故推廣種植暗玉米時，必須愼重預防普通玉米花粉之汚染。

二、暗玉米自交系７種，及由此而來的單交種10種，雙交種７種，以及對照普通玉米２種，分別取其自交果穗分析子粒之化學成分，研究親子間蛋白質，離胺酸及油分含量的關係。結果蛋白質及離胺酸兩項，則單交種之含量均爲兩親中間值，不過凡親本中有較高蛋白質含量者，則單交種之平均值往往低於中間值，否則均有高於中間值趨勢。油分含量的遺傳則以高油分具有顯性，單交種之油分含量均與高油分自交系親本相近或超過之。因此；育種時，應擇自交系之蛋白質與離胺酸含量較高者作爲親本至爲重要。

三、比較雙雜交種玉米蛋白質之胺基酸組成，發現暗玉米比普通玉米具有較高的離胺酸（34.9%），histidine, ammonia, arginine, aspartic acid, glycine, valine 含量。而 proline, alanine, leucine 三種胺基酸含量則少於普通玉米。依胺基酸的平衡營養價值言，暗玉米優於普通玉米。

暗玉米蛋白質比普通玉米具有較多的離胺酸（69%）含量（Mertz 等，1964），故其營養價值遠較普通玉米爲高。本所進行之暗玉米育種，目前已育成多種自交系，以及由這些自交系而來的優良單交種與雙交種，正進行產量比較試驗中，希望不久可以推廣栽培。惟由於初期栽培暗玉米，鄰近田區必有普通玉米種植，所以普通玉米花粉使暗玉米授粉造成的影響，宜有瞭解。本試驗乃分別比較普通玉米、同一暗玉米品種、不同暗玉米品種等三種不同花粉對暗玉米子粒蛋白質、離胺酸及油分含量的直接影響。另一方面，本所選拔之優良自交系，以及由這些自交系雜交而來的單交種或由單交種而來的雙交種，其蛋白質、離胺酸及油分含量變異的情形，亦即自交系親本與雜交後代的化學成分是否一致，可否依自交系的蛋白質、離胺酸或油分含量來推測單交種或雙交種的這些成分的含量。最後，並將雙交種暗玉米及普通玉米之十七種胺基酸組成作一詳細分析，以比較兩者營養價值。

普通玉米蛋白質含量的遺傳研究，報告甚多，結果亦不完全一致。Hayes (1913, 1922), East and Jones (1920), Lindstrom and Gerhardt (1927), Frey (1949), Leng (1951) 等均證實低蛋白含量爲顯性。但 Aseeva (1972), Golodkovoskii (1970) 則認爲蛋白質含量之遺傳爲中間型，並稱母系有較大影響。Ruskova (1974) 亦認爲蛋白質遺傳受輕微的細胞質影響。萬雄等 (1978) 研究暗玉米結果顯示蛋白質含量的遺傳是中間型，但傾向於高蛋白爲顯性，此與過去對普通玉米之研究結

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果不同。

關於暗玉米蛋白質含量與離胺酸含量間的關係，據 Arnold 等（1977）報告，離胺酸%與蛋白質%間有密切的正相關（r=0.70，分離族羣中的暗玉米；或 0.83，純接合暗玉米族羣），可是依 100 gm 蛋白質中之離胺酸含量而言，則與蛋白質%爲負相關（r=−0.12∼−0.33），所以蛋白質含量（%）增加，則離胺酸含量（%）亦隨之增加，但離胺酸產量則不一定。Paez 等（1973）獲得相同的結論（r=0.68），可是普通玉米兩者間的相關則低（r=0.16）。同樣蛋白質含量與 100gm 蛋白質中的離胺酸含量亦爲負相關（r=−0.51）。

Hayes（1919), Leng（1951）等研究普通玉米時，花粉對玉米子粒蛋白質含量，沒有當代的影響，玉米蛋白質含量係由植物的基因型所決定。可是 Sreeramulu and Bauman （1970）研究花粉對暗玉米蛋白質與離胺酸含量的影響，如單交種授以 O_2O_2 植株花粉，或 o_2o_2 與 O_2O_2 植株等量混合的花粉，比較 $O_2o_2o_2$ 與 $o_2o_2o_2$ 胚乳蛋白質的含量，則差異不大，故普通玉米的花粉對暗玉米蛋白質含量似無直接的影響。萬雄等（1978）亦發現暗玉米的蛋白質含量有較高的趨勢。暗玉米天然授粉的結果，對蛋白質與離胺酸的含量均無影響（Sreeramulu, Bauman, and Roth, 1970），不過對暗玉米子粒重量增加顯然較普通玉米爲顯著。

Robutti 等（1973）研究暗玉米蛋白質中胺基酸的組成，發現 lysine, arginine, glycine 及 aspartic acid 等的含量較普通玉米爲高，而 alanine, leucine, phenylalanine 等的含量則較低。

玉米油分的含量一般介於 3.5∼6.0%。在雜結合族羣進行早期選拔，其現實遺傳率 (realized heritability）爲 0.6∼0.7，故油分係具有高度遺傳力的性狀（Spraque, 1977）。在伊利諾試驗場經 61 世代選拔高油分玉米的結果，顯示油分含量與胚的大小有關，高油分玉米常有較大的胚 (Leng, 1961）。可是 Flora 與 Wileg （1972）分析各種突變種玉米的油分時，認爲 opaque-2 基因有降低玉米油分的作用，他們分析的結果，普通玉米含量達 9.5%，而暗玉米僅有 5.2%。Ruskova（1974）研究玉米 F_1 的油分，認爲 F_1 的油分含量有類似花粉直感效應（xenia-like effect），同時並有細胞質影響。

材料與方法

一、試驗材料：

本研究所用的材料計有四類如下：

1.暗玉米自交系七種：TA601, TA602-1, TA604-1, TA606, TA611-3, TA612-1, TA614-1（以下簡稱 1，2^1，4^1，6，11^3，12^1，14^1）。

2.優良暗玉米單交種，係由上列七種自交系雜交而來：1×14^1，$2^1\times1$，$2^1\times6$，$2^1\times14^1$，$4^1\times12^1$，6×4^1，6×14^1，$11^3\times1$，$11^3\times4^1$，$11^3\times14^1$。

3.優良暗玉米雙交種八種，係由上列十種單交種雜交而來：No. 2 〔$(6\times4^1)(2^1\times1)$〕, No. 10 〔$(2^1\times1)(6\times14^1)$〕, No. 46 〔$(2^1\times6)(11^3\times1)$〕, No. 62 〔$(2^1\times6)(1\times14^1)$〕, No. 82 〔$(2^1\times6)(11^3\times4^1)$〕, No. 83 〔$(2^1\times6)$ $(12^1\times14^1$〕, No. 89 〔$(2^1\times6)(11^3\times14^1)$〕, No. 105 〔$(6\times4^1)(2^1\times14^1)$〕。

4.普通玉米：臺南 5 號（TN5），臺南 11 號（TN11）。

二、試驗方法：

供試材料 27 種，田間試驗採用完全逢機設計，單行區，4 重複，行長 3.6 m，行株距 60×30 cm。肥料用量與田間栽培管理和一般玉米栽培法相同。試驗分二項進行：

1.花粉對蛋白質、離胺酸及油分含量的當代影響：三個暗玉米單交種 $4^1\times12^1$，$11^3\times4^1$與$2^1\times14^1$及 No. 2, No. 62, No. 105 等三個暗玉米雙交種，於雌穗吐絲前套袋，分別授予①同株花粉（自交

），②不同暗玉米品種之花粉，③普通玉米臺南 11 號之花粉等三種處理。每穗前後計授粉二次，以確保結實完全。種子成熟後，分別收穫，分析比較三種不同花粉來源之果穗上玉米子粒之蛋白質、離胺酸及油分含量。

2.暗玉米自交系、單交種及雙交種間化學組成分之關係：所有材料於開花吐絲期均分別套袋自交，每穗均行授粉二次，收穫後各行之自交果穗（3～4 穗不等）分別混合爲一樣品，計 4 重複。分析蛋白質，離胺酸及油分含量，比較雙交種，單交種與親本自交系間這些成分的關係。7 個雙交種與兩種普通玉米品種則另行分析胺基酸組成，比較暗玉米與普通玉米蛋白質中各種胺基酸含量的差異。

蛋白質含量測定採用 kjeldahl 及改良 DBC 法（鄭 1977）。離胺酸含量測定，採用離子交換法及改良 DBC 法。油分以 A. O. A. C. 中測粗脂肪法測定之。胺基酸組成分析，則利用自動胺基酸分析儀（Yanagimoto Model LC-5A）分析之。

本文使用單位，蛋白質及油分含量爲乾物重百分比（%），胺基酸爲一百克蛋白質中所含胺基酸克數（g/100g protein）。

結果與討論

一、花粉對蛋白質、離胺酸及油分含量的當代影響

三種不同來源的花粉，授於單交種及雙交種暗玉米後，成熟子粒的蛋白質、離胺酸及油分含量的平均值如表 1。油分含量不論單交種或雙交種，在不同花粉來源間均無顯著差異，表示花粉對油分含量沒有當代的影響，此與 Ruskova (1974) 的結果稍異。不過；就自花授粉種子言供試之暗玉米單交或雙交種與普通玉米比較，普通玉米的油分 4.03～4.36%較暗玉米爲低，而單交種 $4^1 \times 12^1$ 與 $2^1 \times 14'$ 授以普通玉米花粉時，其油分含量各爲 3.67 與 3.96 %，則略爲降低而近於普通玉米。（雙交種由於雜駁族羣，取樣少，無法肯定判斷）。是否由於供試之普通玉米與暗玉米油分含量相差較少，而未能顯示花粉之當代影響，無法肯定。

表 1. 暗玉米以不同來源花粉授粉後，子粒蛋白質、離胺酸及油分含量的平均值 [a]

Table 1. Mean values of protein, lysine and oil contents of opaque-2 maize pollinated with different sources of pollen.

品種 Variety	蛋白質 (%) Protein (%)			離胺酸 Lysine g/100g protein)			油分 (%) Oil (%)		
	自花花粉 Selfing	其他 O_2 玉米花粉 Outcrossing by 02	普通玉米花粉 Outcrossing by +	自花花粉 Selfing	其他 O_2 玉米花粉 Outcrossing by 02	普通玉米花粉 Outcrossing by +	自花花粉 Selfing	其他 O_2 玉米花粉 Outcrossing by 02	普通玉米花粉 Outcrossing by +
$4^1 \times 12^1$	12.89 a	11.45 a	8.38 b	4.93 a	4.50 a	2.88 b	4.89 a	4.64 a	3.67 a
$2^1 \times 14^1$	12.49 a	13.20 a	8.60 b	4.55 a	5.52 a	3.03 b	4.46 a	4.18 a	3.96 a
$11^3 \times 4^1$	12.16 a	11.39 a	8.09 b	4.29 a	3.88 a	2.53 b	4.78 a	4.81 a	4.78 a
D. C. No. 2	11.34 a	11.18 a	8.96 b	4.11 a	4.21 a	3.20 b	5.21 a	4.61 a	4.74 a
D. C. No. 62	10.20 a	9.10 a	8.81 a	3.58 a	3.46 a	3.00 a	4.69 a	4.27 a	4.85 a
D. C. No. 105	11.69 a	10.99 a	8.70 b	4.29 a	4.37 a	2.78 b	4.89 a	4.44 a	4.89 a
臺南 5 號(TN5)	8.91 a	9.20 a	—	2.93 a	3.54 a	—	4.03 a	4.57 a	—
臺南11號(TN11)	8.80 a	9.90 a	—	3.21 a	3.53 a	—	4.36 a	4.59 a	—

a. 平均值上端所註英文字母相同者，其差異未達 5 %顯著水準。

Mean values with letters in common are not significantly different at 5% level.

至於蛋白質與離胺酸之含量，不論單交種或雙交種，如授予不同來源花粉，則有顯著差異。其中，暗玉米自交或授以其他暗玉米品系的花粉，則無顯著差別，而授以普通玉米花粉者，則蛋白質含量顯著降低（表 1），表示普通玉米花粉對暗玉米蛋白質含量具有當代影響。此一結果，與過去的研究結果顯然不同。Hayes (1919) 與 Frey (1951) 以普通玉米爲材料，均認爲蛋白質含量由植株基因型決定，不受花粉之當代影響。而 Sreeramulu, Bauman 與 Roth (1970) 研究暗玉米的結果，亦認爲 $O_2O_2O_2$ 與$+O_2O_2$ 胚乳兩者蛋白質含量無顯著差異，不過就其資料而言，不論何種處理，均顯示$O_2O_2O_2$ 胚乳之蛋白質含量較 $+O_2O_2$ 胚乳爲高（普通玉米（+++）與同背景之暗玉米（$O_2O_2O_2$）之蛋白質含量各爲 10.37 與 10.67 %），而與普通玉米之 10.37 %相近或稍低。所以是否由於 $O_2O_2O_2$ 與 +++兩者蛋白質含量相近，無法顯示普通玉米花粉的當代影響，則需進一步的研究證實。因本試驗暗玉米蛋白質含量，不論單交種或雙交種均在 11 %以上，而普通玉米臺南 11 號則僅有 8.8 %，兩者差異較大。惟其中雙交種 No. 62 之 $O_2O_2O_2$ 與$+O_2O_2$ 胚乳蛋白質含量雖無顯著差異，但$+O_2O_2$ 胚乳的蛋白質含量爲 8.8 %，與普通玉米臺南11號雖完全相等，而雙交種 No. 62 之蛋白質含量則爲 10.2 %，兩者仍然相差達 1.4 % 。故本試驗證實普通玉米花粉對暗玉米蛋白質含量確顯示當代影響，與 Sreeramulu 等的結果不同。

一般而言，應用雙交種測定花粉之直接影響，並不合宜，因雙交種植株間基因型不同，除非能測定多數樣品（單株），以其平均值代表這一雙交種。所幸本試驗各雙交種所用的自交系其蛋白質含量相差不大，故試驗結果，仍有參考價值。

花粉來源對離胺酸的影響，結果與蛋白質含量所受的影響一致並與過去的研究結果相符（Arnold, 1977）。因暗玉米授以普通玉米花粉時，其胚乳基因型 $+O_2O_2$ 的外表型，與普通玉米（+++）相同，離胺酸含量受普通玉米花粉之當代影響而減低。就表 1 結果，凡授普通玉米花粉者，其離胺酸含量均與普通玉米的 3.21 gm/100 gm 蛋白質相近。

根據本試驗結果，將來栽種暗玉米時，應該愼重防止普通玉米花粉之汚染。本試驗結果雖顯示暗玉米品種間發生天然授粉時，則對蛋白質與離胺酸含量均無影響，不過如遇其他暗玉米品種的蛋白質含量較低時，花粉可能產生類似普通玉米同樣的當代影響，亦未可知。

二、暗玉米自交系、單交種及雙交種間化學組成分之關係

暗玉米自交系 7 種，單交種 10 種，雙交種 7 種及對照普通玉米 2 種，經蛋白質、離胺酸及油分含量分析結果，列如表 2 。

（一）蛋白質含量：自交系之變域爲 11.09～14.98 %，單交種爲 11.36～13.43 %。單交種之變域範圍概介於自交系之間，並無任何正負方向超越親本的組合出現。如就各單交種與親本自交系比較，則蛋白質含量介於兩親之間，除 6×4^1，6×14^1，$11^3\times1$，$11^3\times4^1$ 及 $11^3\times14^1$ 等五單交種之平均值略低於兩親中間值外，其餘都較兩親中間值略高，亦即凡單交之兩親中含有蛋白質含量很高的自交系者，則平均值常較中間值略低，此與萬雄等（1978）研究結果相符。而與 Hayes（1913, 1922), East & Jones (1920), Lindstrom & Gerhardt (1927), Frey (1949), ，及 Leng (1951) 等人研究普通玉米的結果低蛋白含量爲顯性結論稍有差別。對於此點，萬雄等（1978）已加以討論。所以本試驗所有十個單交種之蛋白質含量，仍然有一趨勢，即凡親本中有蛋白質含量較高的自交系（4^1，11^3，14^1）者，這些單交種（如 $11^3\times4^1$，$11^3\times14^1$），蛋白質含量均較高。具有蛋白質含量較低的自交系（1，6）者，這些單交種（如 1×14^1，$2^1\times1$，6×4^1，6×14^1，$11^3\times1$） 蛋白質含量均略低。在雙交組合中，各組合之蛋白質含量並沒有顯著差異。比較自交系，單交種及雙交種之變域範圍，發現由自交系，單交種至雙交種，其變域範圍有愈形縮小的趨勢，即自交系爲 11.09～14.98，單交種爲 11.36～13.43，而雙交種則爲 11.08～12.00。再由平均值來看，自交系、單交種、雙交種的平均蛋白質含量分別爲 12.45，12.22，11.49，此顯然由於雜交組合中含有低蛋白質自交系的影響，不論單交種或雙交種，凡低蛋白質自交系數目增多，則雜交種的蛋白質含量即行降低。因此；育成

表 2. 唔玉米自交系、單交種、雙交種之蛋白質、離胺酸及油分含量之平均值[a]

Table 2. Mean values for protein, lysine & oil contents of opaque-2 inbreds, single crosses and double crosses.

組 合 Combinations		蛋白質 Protein	離胺酸 Lysine	油分 Oil
自交系 Inbreds	1	11.09 ± 0.25 d	4.03 ± 0.15 c	4.32 ± 0.68 a
	2^1	11.45 ± 0.39 c	4.05 ± 0.32 c	3.76 ± 1.00 a
	4^1	12.58 ± 0.98 abc	4.76 ± 0.14 b	4.05 ± 0.69 a
	6	11.16 ± 0.38 d	3.80 ± 0.28 c	4.41 ± 0.78 a
	11^3	14.98 ± 1.05 a	5.78 ± 0.65 a	3.88 ± 0.73 a
	12^1	12.42 ± 0.53 bc	4.80 ± 0.58 b	4.12 ± 0.70 a
		13.49 ± 0.76 ab	4.47 ± 0.38 b	4.11 ± 0.49 a
	平均 Mean	12.45	4.53	4.09
單交種 Single crosses	1×14^1	12.36 ± 0.31 bcd	4.62 ± 0.34 bcd	4.40 ± 1.07 a
	$2^1 \times 1$	11.49 ± 0.48 cd	3.96 ± 0.30 e	4.39 ± 0.73 a
	$2^1 \times 6$	11.59 ± 0.34 cd	4.09 ± 0.49 de	4.65 ± 0.19 a
	$2^1 \times 14^1$	12.49 ± 0.33 abc	4.54 ± 0.13 bc	4.46 ± 1.18 a
	$4^1 \times 12^1$	12.89 ± 0.75 ab	4.93 ± 0.34 ab	4.89 ± 0.83 a
	6×4^1	11.36 ± 0.93 d	4.08 ± 0.45 de	4.28 ± 0.71 a
	6×14^1	11.55 ± 0.67 cd	4.20 ± 0.39 cde	4.63 ± 0.62 a
	$11^3 \times 1$	12.16 ± 0.88 bcd	4.33 ± 0.24 cd	4.59 ± 0.15 a
	$11^3 \times 4^1$	12.91 ± 0.49 ab	4.74 ± 0.19 abc	4.16 ± 0.75 a
	$11^3 \times 14^1$	13.43 ± 0.88 a	5.22 ± 0.27 a	4.95 ± 0.52 a
	平均 Mean	12.22	4.46	4.54
雙交種 Double crosses	$(6 \times 4^1)(2^1 \times 1)$	11.34 ± 0.91 a	4.11 ± 0.59 a	5.21 ± 0.21 a
	$(2^1 \times 1)(6 \times 14^1)$	11.21 ± 0.84 a	3.95 ± 0.33 a	4.12 ± 1.12 a
	$(2^1 \times 6)(11^3 \times 1)$	11.08 ± 0.79 a	3.88 ± 0.29 a	4.57 ± 0.92 a
	$(2^1 \times 6)(11^3 \times 4^1)$	11.48 ± 0.40 a	4.25 ± 0.19 a	4.78 ± 0.48 a
	$(2^1 \times 6)(12^1 \times 4^1)$	11.67 ± 0.54 a	4.16 ± 0.17 a	4.65 ± 0.48 a
	$(2^1 \times 6)(11^3 \times 14^1)$	12.00 ± 0.48 a	4.35 ± 0.17 a	4.70 ± 1.21 a
	$(6 \times 4^1)(2^1 \times 14^1)$	11.69 ± 0.56 a	4.29 ± 0.15 a	4.89 ± 0.23 a
	平 均 Mean	11.49	4.14	4.70
	臺南5號(T. N. 5)	8.91 ± 0.52 b	2.93 ± 0.31 b	4.03 ± 0.64 a
	臺南11號(T. N 11)	8.80 ± 1.15 b	3.21 ± 0.29 b	4.36 ± 0.58 a

a. 平均值上端所註英文字母相同者，其差異未達 5 %顯著水準。
Mean values with letters in common are not significantly different at 5% level.

雜交品種時，如就蛋白質含量而言，低蛋白質自交系親本數目愈少愈好。

(二) 離胺酸含量：結果和蛋白質之情形頗爲相似。自交系之變域爲 3.80～5.78，單交種 3.96～5.22，雙交種 3.88～4.35，變異範圍亦未超出親本。離胺酸含量較低的自交系（1，2^1，6），不論作爲父本或母本，凡與其組合的單交種（$2^1 \times 1$，$2^1 \times 6$，6×4^1，6×14^1，$11^3 \times 1$），離胺酸含量均較低。而離胺酸含量高之自交系(4^1，11^3，12^1，14^1)，互相組成之單交種($11^3 \times 4^1$，$11^3 \times 14^1$，$4^1 \times 12^1$)，其含量則高。在雙交種中，離胺酸含量的變域爲 3.88～4.35，亦較自交系或單交種爲小。自交系、單交種及雙交種離胺酸含量之平均值分別爲 4.53，4.46，及 4.14，亦與蛋白質含量之遞變情形相似。故雜交後代離胺酸含量與蛋白質含量的變化具有同一趨勢。育種時，對於自交系親本的選擇，同樣以應用高含量者爲宜。

(三) 油分含量：自交系間並無顯著差異，變域爲 3.76～4.41。單交組合間及雙交組合間亦均

無顯著差異，變域分別是 4.16～4.95 及 4.12～5.21 。但就自交系，單交組合至雙交組合比較，其平均值則漸增（4.09→4.54→4.70）。如依單交種與兩親本自交系的含油量比較，則可發現除（6×4^1）外，其餘各單交種之含油量均與高油量親本相近或超越之，顯示油分含量的遺傳，高油量爲顯性並有超顯性的趨勢。根據 Spraque（1977）報告，玉米油分含量爲一具有高遺傳率的性狀（$h^2=0.6-0.7$），其受環境變異影響較小。因此，只要善加選拔，提高油分含量的育種工作，其成功機會較大。

三、雙交種暗玉米蛋白質的胺基酸組成

七種雙交種暗玉米及兩對照種普通玉米經分析 17 種胺基酸組成分之結果列如表 3 。胺基酸組成在不同雙交種間的變異很大，同爲暗玉米，各種胺基酸含量的多寡，亦視品種之不同而有很大的差異，如 ammonia, No. 46 爲 0.88, No. 83 爲 1.85, No. 82 爲2.17，相差達二倍以上。 glycine, No. 46 爲 6.61，No. 83 爲 2.47，兩者 alanine 含量又分別爲 6.92，16.08 ，差距更大。一般而言，暗玉米之 lysine, histidine, aspartic acid, ammonia, arginine, glycine, valine 等 7 種胺基酸含量均比普通玉米爲高，而 proline, alanine 及 leucine 三種則比普通玉米少，此分析結果與 Robutti等（1973）的結果相同。依胺基酸之營養平衡觀點而言，暗玉米遠優於普通玉米。

表 3. 暗玉米雙交種及對照品種蛋白質之胺基酸組成

Table 3. The amino acid composition of double-cross opaque-2 and normal corn.

胺基酸 Amino acid	No. 2 (6×4^1) ($2^1\times1$)	No. 10 ($2^1\times1$) (6×14^1)	No. 46 ($2^1\times6$) ($11^3\times1$)	No. 82 ($2^1\times6$) ($11^3\times4^1$)	No. 83 ($2^1\times6$) ($12^1\times4^1$)	No. 89 ($2^1\times6$) ($11^3\times4^1$)	No. 105 (6×4^1) ($2^1\times14^1$)	TN 5 (ck)	TN11 (ck)
Lysine	3.38	4.61	3.97	4.41	2.43	4.70	3.46	3.19	2.05
Histidine	3.71	3.59	2.88	4.88	3.63	4.09	3.13	3.14	2.55
Ammonia	1.02	1.14	0.88	2.17	1.85	1.46	0.96	0.64	0.90
Arginine	5.35	4.83	4.42	6.71	4.76	7.02	4.86	4.65	3.26
Aspartic acid	7.45	8.98	8.80	7.62	5.30	7.87	7.55	7.56	5.76
Threonine	4.40	6.00	5.33	4.77	4.74	5.40	3.76	3.69	4.72
Serine	3.40	3.31	2.92	3.24	4.29	3.98	3.96	3.39	4.26
Glutamic acid	19.25	16.76	15.61	18.43	21.14	19.25	20.11	18.49	22.15
Proline	11.92	11.60	11.27	8.01	11.23	7.62	9.71	13.66	11.54
Glycine	3.77	6.41	6.61	4.49	2.47	4.57	4.47	3.89	3.13
Alanine	9.16	6.11	6.92	13.69	16.08	11.63	10.80	15.52	14.01
½Cystine	1.60	0.58	1.35	1.52	1.29	0.45	1.75	1.23	1.01
Valine	6.36	3.34	4.11	6.67	3.07	5.50	6.97	4.21	3.89
Methionine	0.75	1.39	1.49	0.99	1.01	0.99	0.83	0.78	1.00
Isoleucine	2.46	3.10	4.39	2.34	2.52	2.80	1.81	2.73	3.00
Leucine	7.81	11.37	10.99	5.81	9.12	7.96	7.38	8.36	11.19
Tyrosine	1.71	2.50	3.03	1.60	1.86	1.63	1.77	1.79	1.92
Phenylalanine	3.00	4.41	6.83	2.65	3.19	3.06	2.76	3.08	3.64

參 考 文 獻

1. 萬雄、呂宗佳、鄭心嫻·1978。暗玉米蛋白質含量之遺傳。中華農業研究 27:53-60。
2. 鄭心嫻·1977。應用 DBC 法測定玉米子粒離氨酸含量之研究。科學發展月刊 5 :386-392。
3. Arnold, J. M., L. F. Bauman & H. S. Aycock. 1977. Interrelations among protein, lysine, oil, certain mineral element concentrations and physical kernel characteristics in two maize populations. Crop Sci. 17 : 421-425.
4. Aseeva, I. B. 1972. Protein metabolism in seeds of heterotic maize hybrids. Selektsiya i Semenovodstovo 22 : 51-57 (PBA/45 : 422, 1975).
5. East, E. M. & D. F. Jones. 1920. Genetic studies on the protein content of maize. Genetics 5 : 543-610.
6. Flora, L. F. & R. C. Wiley. 1972. Effect of various endosperm mutants on oil content and fatty acid composition of whole kernel corn (*Zea mays*, L.). J. Amer. Soc. Hort. Sci. 97 : 604-607.
7. Frey, K. J. 1949. The inheritance of protein and certain of its components in maize. Agron. J. 41 : 113-117.
8. Frey, K. J. 1951. The interrelationships of protein and amino acids in corn. Cereal Chem. 28 : 123-132.
9. Hayes, H. K. 1913. Corn improvement in Connecticut. Conn. Agri. Expt. Stn. Rept. 6 : 353-384.
10. Hayes, H. K. 1922. Production of high protein maize by Mendelian methods. Genetics 7 : 237-257.
11. Hayes, H. K. & R. J. Garber. 1919. Synthetic production of high protein corn in relation to breeding. J. Amer. Soc. Agron. 11 : 309-318.
12. Golodkovoskii, V. A. 1970. Protein content in the grain of varietal-line and double interline hybrids of maize and their parent forms. Uzb. biologiya Z. No. 1 : 55-56 (Russian) (PBA 43 : 153, 1973).
13. Leng, E. R. 1961. Predicted and actual responses during longterm selection for chemical composition in maize. Euphytica 10 : 368-378.
14. Leng, E. R., F. R. Earle & J. J. Curtis. 1951. Direct effect of pollen parent on protein content of the corn kernel. Cereal Chem. 28 : 379-482.
15. Lindstrom, E. W. & E. Gerhardt. 1927. Inheritance of chemical composition of maize. Iowa State Coll. J. Sci. 2 : 9-18.
16. Mertz, E. T., L. B. Bates & O. E. Nelson. 1964. Mutant gene that changes protein composition and increases lysine content of maize endosperm. Science 145 : 279-280.
17. Paez, A. V. & M. S. Zuber. 1973. Protein quality study with the endosperm corn mutant gene opaque-2 and floury-2. Can. J. Plant Sci. 53 : 715-720.
18. Robotti, J. L. , R. C. Hoseney & C. W. Deyoe. 1974. Modified opaque-2 corn endosperms. 1. Protein distribution and amino acid composition. Cereal Chem. 51 : 163-172.
19. Ruskova, K. 1974. The effect of the direction of the cross on oil, protein and lysine content in the grain of maize. Genetika i Selektsiya 7 : 353-360. (PBA 45 : 422, 1975)
20. Sprague, G. F. 1977. Corn and corn improvement. Amer. Soc. Agron. Madison, Wisconsin, USA. pp. 363-370.
21. Screeramulu, C. & L. F. Bauman, 1970. Yield components and protein quality of opaque-2 and normal diallels of maize. Crop Sci . 10 : 262-265.
22. Screeramulu C. , L. F. Bauman, & Gary Roth. 1970. Effect of outcrossing on protein quality, kernel weight, and related characters in opaque-2 and floury-2 maize (*Zea mays*, L.). Crop Sci. 10 : 235-236,

Effects of pollen sources on protein, lysine and oil contents of different cross-combination of opaque-2 corn[1]

Hsiung Wan, Tzong-chia Lee, Hung-shung Lu and Hsing-hsien Cheng[2]

Summary

The purpose of this study is to investigate the xenia effect of pollen from both opaque-2 and normal corn on protein, lysine and oil contents and the relationship of these chemical constituents between parental inbreds and their subsequent single and double crosses. The amino-acid compositions of the double-cross hybrids made from the opaque-2 inbreds were also analysed.

Two single crosses and three double crosses were pollinated respectively with its own pollen (selfing), unrelated opaque-2 lines (outcrossing), and normal corn (Tainan No. 11) pollens. The results showed that there was no xenia effect of pollen on oil content. However, there were significant xenia effects on protein and lysine contents if opaque-2 corn was pollinated with pollens from normal corn. Both protein and lysine contents were reduced to the level of normal corn which contained less protein (8.8%) and lysine (3.21gm/100gm protein). Outcrossing with unrelated opaque-2 corn did not affect the two constituents. The conclusion on no xenia effect with opaque-2 corn pollen should be cautiously referred without further studies because this would possibly be due to the narrow differences of protein and lysine contents between pollen parent and female parents (single or double crosses). Nevertheless, the information is useful for the production of opaque-2 corn to avoid the contamination of pollens from normal corn.

Seven opaque-2 corn inbreds and 10 single crosses, and 7 double crosses obtained from these inbreds were studied for their protein, lysine and oil contents. The results showed protein and lysine contents of each single cross were intermediate between two parent inbreds while the chemical constituents of the double crosses were also the intermediate of two single crosses. However , the oil content of the single cross is equal to or surpasses the higher inbred except the single cross, 6×4^1, indicating that high oil content is dominant . For double crosses, the oil content was intermediate between two parental single crosses.

The complete analysis of amino-acid composition of 7 double crosses indicated that opaque-2 corn contained higher lysine, histidine, aspartic acid, arginine, ammonia, glycine and valine, and less proline, alanine and leucine than normal corn. Although

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there are differences of amino acid composition between opaque-2 and normal corn, the opaque-2 corn shows more balanced amino acid composition and thus has higher nutritional value than normal corn.

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長荚種黃麻之纖維性狀與紙漿品質之研究[1]

胡 敏 夫　韓 青 梅[2]

摘要：經二年田間觀察與調查，獲悉所參試品種中，JRO-632 與 61-1-I-2098 兩品種具有頗高生產潛力，精洗率前者達 12.85 %，後者達 11.95%，公頃平均精洗蔴產量均達 3,000 kg 以上，比對照種增產 25 %左右。纖維性狀調查，發現長莢種纖維層次有較圓果種多之趨勢，單位面積纖維束數亦較圓果種多。韌皮部及木質部厚度，確比圓果種細小，纖維拉力負荷値比圓果種大，耐屈力則反是。單纖長幅比，除 JRO-753 及 JRO-632 兩品種外，其餘參試品種略有近似或高於圓果種之趨勢。以全莖蔴桿爲材料供造紙，紙漿收率及未漂白紙張物理性能均比本省產濶葉假赤楊優異，實有取代濶葉樹之價値。以精洗蔴爲材料供造紙，雖紙漿收率及未漂白紙張物理性能亦可媲美美國南部松之紙漿品質，但較費工推行不易。

黃蔴爲一年生草本植物，原產於錫蘭及熱帶亞洲地區，栽培種類有食用及纖維用兩種[2]。在纖維品種中受人類栽培利用者，有圓果種 (*Corchorus capsularis* L.) 及長莢種 (*Corchorus olitorius* L.) 二種。圓果種因產量高，纖維品質優異，在本省栽培面積於 1955 年曾達 14,959.80 ha [3]。長莢種以往未曾在本省栽培，其適應性及農藝特性，僅憑國外資料報導未能詳悉，但據文獻記載其表皮薄，莖部細長，產量低[1]，在本省僅及觀察試驗未受重視，在國外因其纖維較細，易於混紡，頗受重視栽培，其纖維售價比圓果種高[10]。1978年4月間奉行政院徐副院長指示，再行辦理黃蔴長莢種品種觀察，並探究其在本省之適應性及其用途，乃將先前由國外引進長莢種七品系並以一圓果種爲對照，辦理品種觀察，調查其主要農藝性狀、產量、纖維品質及供造紙之原料，以增加農民收益。

材 料 與 方 法

本試驗於 67 年及 68 年4月上旬，分別在臺南農場及霧峰本所農場進行。供試品種計有 (A). ECR/576, (B). Chin sura green, (C). D-154, (D). JRO-753, (E). JRO-620, (F). JRO-632, (G). 61-1-I-2098 等七種長莢種及圓果種 (CK). Taichung No. 4 一種爲對照。試驗方法，採逢機完全區集法設計，4重複，行長 4 m、行距 50 cm、4行區，小區面積 8 m^2。每小區於收穫時，選大小中庸之鮮株4株，取其中部 5 cm 長之莖爲樣品，剖開浸漬於 FAA (Formalin 5 ml Acetic acid 5 ml Alcohol 90 ml) 固定液固定三天，再以 70 %酒精冷藏，然後隨時取出用徒手切片法切片，並以 Phloroglucin 染色劑染色後，行鏡檢測定，以比較各品種之纖維細胞特性，作爲纖維品質優劣之研判參考。纖維品質之測定，係以拉力測定機 (Scott tester) 與耐屈力測定機 (Flex tester) 分別測定各品種精洗蔴 (Retted fibers) 之拉力與耐屈力。單纖測定，係先將鮮蔴皮 (Bast) 軟化，使單纖維易以分離以便供置於顯微鏡下測定。軟化方法採 1960 年 H. J. Nieschlag 氏等所報導方法處理[8]，即將鮮蔴皮存置於 30 ml 蒸餾水裡，然後加 0.5 ml 冰醋酸 (Glacial acetic acid)

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1. 臺灣省農業試驗所 研究報告 第 1012 號。本研究第一作者，承國家科學委員會獎助，謹致謝忱。
2. 本所農藝系助理。臺灣省 臺中縣 霧峰鄉

，次再加 1g 亞氯酸鈉（Solid sodium chlorite），使呈爲混合液，將此混合液置於自動溫度控制之熱水槽（Water bath）內，加熱至 75°C。此後每隔一適當時間加入 0.5 g 量之亞氯酸鈉，並輕輕搖動，約經 6 小時後可發現試管內之纖維轉變成白色，同時與膠質分離，稍爲搖動可清晰看見單纖浮動，此時即可注入熱水稀釋，徐徐將膠質及表皮洗去，最後用小瓢取出單纖液體，置於載玻片上供鏡檢，以測定其單纖長度、寬度及長幅比。另以全莖麻桿及精洗麻兩種爲造紙試驗材料，分別以中性亞硫酸鈉法及硫酸鹽法蒸煮，製漿及抄紙，以比較其紙張物理性能。

結 果 與 討 論

一、長莢種黃麻之農藝特性

表 1. 長莢種黃麻之農藝特性

Table 1. Agronomic characteristics of the olitorius varieties of jute

Variety	Days to blooming	Plant height (cm)	Stem length (cm)	Stem diameter (cm)	Thickness of fresh crude fiber (mm)	Yield of ratted fiber (kg/ha)	Index (%)	Retting (%)
ECR/576	115	296.8	232.9	1.53	154.2	2,112.5	87.2	10.43
Chin Sura Green	93	276.6	157.0	1.44	138.5	2,181.3	90.0	11.75
D-154	93	311.8	157.5	1.41	147.6	1,875.0	77.4	11.45
JRO-753	115	294.6	188.5	1.43	142.5	2,493.8	103.0	11.30
JRO-620	116	285.0	198.1	1.40	149.0	2,450.0	101.0	11.45
JRO-632	130	283.0	195.4	1.45	159.5	3,043.8*	125.7	12.85
61-1-I-2098	126	294.8	198.8	1.45	150.0	3,043.9*	125.7	11.95
CK. Tainung No. 4	108	282.0	231.5	1.69	152.6	2,422.0	100.0	9.90

* Significant at 5% level.

經二年觀察結果（如表 1），獲悉始花期在所有參試之長莢種中，除了 Chin sura green 及 D-154 兩品種外，其他品種均較對照種臺農 4 號遲，莖長則反是。鮮皮厚度以 JRO-632 品種最厚達 159.5mm 。公頃平均精洗麻產量，以 JRO-632 與 61-1-I-2098 兩品種最高達 3000 kg 以上，較對照種增產 25 %左右經綜合變方分析結果，各達 5 % 顯著差異水準，精洗率（Retting）亦比對照種高，各達 12.85 與 11.95 %。由此可知長莢種在本省栽培尚可適應，惟栽培上應注意排水，種植密度應較圓果種略密，以防早期分枝而增加有效莖長，在多濕環境下，又經常有濃霧地區，應注意防治炭疽病發生。

二、纖維細胞性狀之觀察

纖維細胞性狀之優劣關係纖維品質至鉅，據凌千里1972年作黃麻纖維細胞組織與纖維品質之關係研究報告[5]，顯示「纖維細胞長幅比與拉力負荷，細胞壁厚與耐屈力等，均呈顯著正相關 ， 細胞直徑與纖維拉力負荷及耐屈力間之相關，雖未達顯著標準，但有此趨勢」。本試驗並進一步測定各品種之韌皮部厚度，木質部厚度，纖維層次及單纖細胞直徑與細胞壁厚度，所獲結果如表 2 及表 3 。

從表 2 知參試之長莢種之韌皮厚度均較圓果種薄，木質部亦比圓果種小，顯示長莢種之莖部實比圓果種細小，此與臺灣纖維資源所報導資料相埒[1]。纖維層次除 D-154 與 JRO-632 品種外，其餘品種均比對照種多一層次，因之拉力負荷值亦大（纖維層次多寡與拉力負荷值呈正相關）。細胞直徑

表 2. 長莢種黃麻品種間纖維細胞特性之比較

Table 2. Comparison of the fiber cell characteristics of the olitorius varieties of jute

Variety	Thickness of phloem (mm)	Thickness of xylem (mm)	No. of fiber layers	Cell diameter (μ)	Thickness of cell wall (μ)
ECR/576	0.82	3.17	7	17.1	5.4
Chin Sura Green	0.68	3.01	7	17.6	5.3
D-154	0.73	2.91	6	17.0	5.4
JRO-753	0.84	3.01	7	16.7	4.9
JRO-620	0.83	2.62	7	15.5	4.6
JRO-632	0.66	3.07	6	15.6	4.3
61-1-I-2098	0.78	2.42	7	17.5	5.4
Tainung No. 4	0.86	3.87	6	17.1	5.9

測定結果，JRO-632 與 JRO-620 兩品種較小，其餘品種與對照種相互比較差異不大。細胞壁厚度亦有相同趨勢，至於單位面積內之纖維束數，長莢種顯然比圓果種多（如圖1、2）。單纖細胞之測定，其結果如表3。

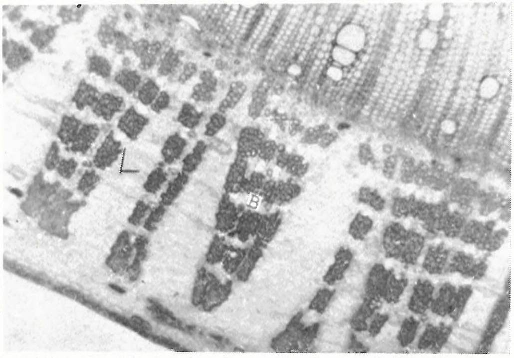

圖 1. 長莢種黃麻纖維束及纖維層次（400X）

Fig. 1. Fiber bundles and fiber layers of *olitorius* jute (400x)

圖 2. 圓果種黃麻纖維束及纖維層次（400X）

Fig. 2. Fiber bundles and fiber layers of *capsularis* jute (400x)

據凌氏文中敍述印度 IARI 1955 年年報報告，黃麻纖維拉力佳者，單纖細胞較長亦較細，長幅比亦較大，其趨勢在長莢種尤爲明顯[5]，但經測定結果如表3顯示，除 D-154, JRO-620 兩品種之長幅比較大外，其餘品種之長幅比與對照種比較差異甚微，且均分佈在 105～110 之間。

表 3. 長莢種黃麻品種間單纖維之長幅比

Table 3. Length-width ratio of single fiber cell oe the olitorius varieties of jute

Variety	Length (mm)	Width (mm)	Length-width ratio
ECR/576	1.92	0.0174	110.0
Chin Sura Green	1.84	0.0167	110.0
D-154	2.48	0.0174	142.5
JRO-753	1.53	0.0145	105.5
JRO-620	2.51	0.0186	134.9
JRO-632	1.70	0.0155	109.6
61-1-I-2098	1.99	0.0180	110.5
Tainung No. 4	1.95	0.0177	110.2

三、拉力及耐屈力測定

拉力 (breaking load) 爲測定纖維品質中最重要之一項，因測定方法之不同亦可稱爲拉力長度 (Breaking length) 或拉力强度 (Tensile strength)。耐屈力 (Flex flexural endurance) 爲測定其纖維捲繞性，耐屈力差者纖維粗硬易破碎，紡紗加工時不易捲繞。據 Dempsey 氏稱，長莢種纖維通常均比圓果種柔軟、强韌，且具有光澤[9]。又品質良好之長莢種商品，在印巴市場上商用名稱爲 Dacca tossa[4,10]。本省試種經浸鍊之精洗麻是否能媲美國外品質値得研究，乃再進一步進行機械測定（測定方法如圖3），其測定結果如表4。

樣品 (Sample) —— 分段 (Sub-sample) ——梳整 (Combing) ——裁樣 (Cutting)
作圈 (Looping) —— 秤重 (Weighing) ——撚捻 (Twisting) ——粘貼 (Mounting)
測定 (Testing).

圖 3. 拉力和耐屈力測定方法

Fig. 3. Strength and flex testing method

表 4. 長莢種黃麻品種間精洗麻纖維品質之比較

Table 4. Comparison of the retted fiber quality of the olitorius varieties of jute

Variety	Breaking load (1b)	Flex (cycle)
ECR/576	28.82	316
Chin Sura Green	33.42	451
D-154	30.92	367
JRO-753	30.02	208
JRO-620	31.32	487
JRO-632	29.62	366
61-1-I-2098	29.02	335
Tainung No. 4	29.22	730

從表 4 資料顯示，所參試之長莢種 Chin sura green、D-154、JRO-753、JRO-620、JRO-632 等五個品種之拉力負荷値各比對照種高 4.2、1.7、0.8、2.1、0.4 磅等，顯然因受纖維層次及單位面積內纖維束數多寡因素所左右，如表 2 之纖維特性調查顯示，大部份參試之長莢種纖維層次（number of fiber layers）均比圓果多一層次，藉此似可證實拉力負荷與纖維層次多寡有密切關係。至於耐屈力測定之結果，對照種均比長莢種高 243 圈至 414 圈之間，顯示本省所生產之長莢種纖維尚難供紡紗用。

四、全莖麻桿及精洗麻造紙試驗

（一）全莖麻桿造紙：

將麻桿梢部削除 40 cm 左右，置於田間晒乾，晒乾後分基、中、梢三部剪斷，然後細切成 1～1.5 吋長度，混合成樣品並經打碎。取樣時每品種取二個樣品，每一樣品乾重 200 g，以硫酸鹽法在高溫 170°C 下蒸煮 2 小時，然後洗滌置於分散機 （Disintegrator） 攪打、過濾、風乾，後定水分並計算細漿收率及測定游離度，其次再打漿抄紙，再依照 Tappi standard 抄紙，以測定紙張物理性質，並以本省產濶葉樹假赤楊紙漿及抄紙後之物理性質相比，試驗結果如表 5 。

表 5. 長莢種黃麻全莖麻桿造紙品質之比較

Table 5. Comparison of the quality of unbleached pulp mede of stems of the olitorius varieties of jute

Variety	Yield of pulp (%)	Freeness C. S. F. (ml)	Breaking length (km)	Burst factor ($g/cm^2/g/m^2$)	Tear factor ($g/g/m^2$)
ECR/576	45.5	550	11.0	61.9	113.5
Chin Sura Green	50.5	539	11.3	64.3	107.3
D-154	48.4	547	10.2	57.0	117.9
JRO-753	47.0	530	10.6	56.5	119.5
JRO-620	46.1	539	10.6	58.3	112.5
JRO-632	49.9	510	11.1	62.8	105.1
61-1-I-2098	51.0	550	10.6	61.0	122.6
Tainung No. 4	46.1	428	10.3	52.4	121.2
Hardwood of Taiwan	49.0	320	9.3	54.8	63.3

（二）精洗麻造紙：

精洗麻造紙試驗方法有蘇打法（Soda cooking），硫酸鹽法（Sulfate cooking）及中性亞硫酸鈉法（Neutral sulfite cooking）等三種，但經試驗比較結果，發現黃麻精洗麻製漿方法，以中性亞硫酸鈉法較佳，因其K價雖較高難漂，但在適當情況下能使紙漿漂白度達到 70% GE 而保存其強度。玆採用此方法進行試驗，並以美國南部松之紙漿品質作爲對照，其試驗結果詳如表 6 。

表 6. 長莢種黃麻精洗麻造紙品質之比較

Table 6. Comparison of the quality of unbleached pulp made from retted fiber of the olitorius varieties of jute by netural sulfite cooking method

Variety	Yield of pulp (%)	Freeness C. S. F. (ml)	Breaking length (km)	Burst factor ($g/cm^2/g/m^2$)	Tear factor ($g/g/m^2$)
ECR/576	81.02	343.5	10.14	136.0	76.5
Chin Sura Green	77.83	335.0	8.43	119.5	61.5
D-154	80.08	391.5	9.46	148.5	65.5
JRO-753	78.63	374.5	9.47	120.5	64.5
JRO-620	82.11	347.0	8.04	151.0	59.0
JRO-632	80.40	384.0	8.29	175.0	57.0
61-1-I-2098	79.37	364.5	8.45	174.0	61.0
Tainung No. 4	84.43	405.0	8.71	177.5	63.0
U. S. Southern Pine	43.10	550.0	10.50	148.0	78.0

全莖麻桿製漿試驗結果（如表5），發現紙漿收率以 Chin Sura green, JRO-632, 61-1-I-2098 等三品種較高，各達 50.5、49.9、51%，分別比對照種高，且優於省產之濶葉樹假赤楊。紙漿游離度 (Freeness) 則所有參試之長莢種均比對照種高，亦比假赤楊樹優異甚多。至於紙張物理性能 (Physical properties of paper) 如斷裂長 (Breaking length)、破裂比 (Burst factor)、撕裂比 (Tear factor) 等，品種間差異雖甚微，但優以假赤楊樹，尤以 JRO-632、61-1-I-2098 二品種爲最。

精洗麻製漿試驗結果如表6，獲悉所有參試之黃麻長莢種細漿收率均相當高，尤以對照種爲最，高達 84.43 %幾爲美國南部松之二倍高。紙張物理性能以 ECR/576, Chin sura green, D-154, JRO-753 品種較 JRO-620, JRO-632, 61-1-I-2098, Tainung No. 4 品種佳，可媲美美國南部松之紙張物理性能。

結　　論

綜合上述結果得悉，所引進之長莢種黃麻以 JRO-632 與 6-1-I-2098 兩品種較可適應，生產潛力高，韌皮部比圓果種薄，木質部亦較小，與國外種植所報導資料相埒 (1)。纖維層次大部份長莢種均比圓果種多一層次，單位面積內纖維束數長莢種亦比圓果種多，爲長莢種拉力負荷值均高於對照種之故。單纖長幅比 (Length-width ratio)，除 JRO-753, JRO-632 兩品種外，其餘之長莢種略爲高於或近似於圓果種之趨勢，此與 IARI 1955 年年報所報告者相符合 (5)。惟耐屈力所有參試長莢種均比圓果種差，因之，長莢種黃麻纖維認爲比圓果種纖維較易混紡頗令人置疑。由造紙試驗獲悉，以全莖麻桿爲造紙材料之所有參試品種細漿收率，均比本省產濶葉樹假赤楊高，且紙張物理性能（未漂白紙張），並比濶葉樹之紙張優，可降低造紙成本，因此頗有取代濶葉樹之價值。以精洗麻爲造紙材料，雖細漿收率高於美國南部松，但費工太多在今日農村勞力不足之情勢下，較不經濟尚難採行。

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參考文獻

1. 王祖濤・1950・臺灣之纖維資源・35-36・臺灣新生報新生印刷所編印。
2. 汪呈因・1959・作物育種學・264-270・正中書局。
3. 季景元・1959・臺南棉麻手册。
4. 谷雲川、邱俊雄・1972・濶葉樹材混合製漿造紙試驗・6-7・林業試驗所。
5. 凌千里・1972・臺灣黃麻纖維品質及改善研究・8(1):154-164・臺灣農業。
6. 凌千里・1972・黃麻纖維細胞組織與纖維品質之關係研究農業研究・21(2):103-118・
7. 趙順中、林澤南・1969・臺灣濶葉樹林牛皮紙漿製造研究・(油印本)。
8. H. J. Nieschla et. al. 1960. A search for new fiber cropr. Tappi 43(3) : 193.
9. James. M. Dempsey. 1975. Fiber crops. : 132-193. University presses of Florida.
10. Ludwig Weindling. 1974. Long vegetable fibers. : 163-231. New York Columbia University press.

Studies on fiber characters and pulp qualities of jute *Corchorus olitorius* L.[1]

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Summary

The present studies dealt with the jute fiber cell characters as well as the qualities of pulp made of jute fibers.

After two years studies, varieties JRO 632 and 61-1-I-2098 were found to have a higher yield potential in the seven *olitorius* varieties tested. Vareities JRO 632 and 61-1-I-2098 each gave 12.85% ane 11.95% of retting rate which represented about 3000 kg of retted fiber production per hectare. This account for 25% higher fiber production than that of *capsularis* variety.

Olitorius varieties showed more fiber layers, more fiber bundles, thinner phleom and xylem and better fiber strength but inferior flex in comparison with *capsularis* variety. In general, the length-width ratios of *olitorius* varieties were similar or better than that of *capsularis* variety with the exception of varieties JRO 735 and JR 632. In view of the good quality of unbleached pulp made of the whole stem (fiber plus pith) of *olitorius* jute, it was considered that *olitorius* juts could be used as the good raw materials for pulp making in place of wood.

The unbleached pulp made of retted fibers only showed equally good quality as that made of southern pine of U. S. A. However, labor cost involved in fiber retting should be solved before it can be economically used as the raw materials for pulp making.

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不同支架型式對山藥產量及品質之影響[1]

徐 原 田[2]

摘要：爲了探討不同支架型式對於山藥（*Dioscorea alata* L.）塊根產量及品質之影響，乃舉行本研究。本研究自 1979 年 1 月至 1980 年 2 月止。依支架型式不同分爲高支架（6 尺），中支架（4 尺半），矮支架（3 尺），半弧形支架（3 尺）及對照區（黑色塑膠布覆蓋）計有 5 種處理。茲將研究結果摘述如下：

1.山藥初期生育受不同支架之影響，各處理間差異大，株高、節數、分蘖數均以半弧形支架（3 尺）處理較佳。

2.支架型式以高支架（6 尺）處理對地上部莖葉之乾重量，每株平均比對照（黑色塑膠布覆蓋）處理可增加 36 %，半弧形支架（3 尺）處理增加 10 %；地下部之塊根產量平均每株高支架（6 尺）處理可增加 33 %，半弧形支架（3 尺）處理增加 11 %，中支架（4.5尺）處理增加 2 %；由於高支架（6 尺）處理有利於塊根之肥大，其他半弧形支架（3 尺）及中支架（4 尺半）處理亦佳，產量各增加 0.154，0.051 及0.01kg／株。

3.以單位面積產量言，高支架（6 尺）處理時產量最佳，對地下部塊根產量每公頃比對照（黑色塑膠布覆蓋）可增加 33 %；且根形，品質均屬最佳，蛋白質含量提高 2.83 %；其次半弧形支架（3 尺）處理可增加 11 %，根形，品質亦佳，其蛋白質含量亦提高 0.83 %；其他中支架（4 尺半）及矮支架（3 尺）處理蛋白質含量均有提高之趨勢。

山藥（*Dioscorea alata* L.）爲多年生宿根植物。其塊根爲常用藥材，神農本草經列爲上品[(8)]。因其富含澱粉、蛋白質、粘液質及其他成分物質，具有很高的營養價值[(1,2,3,4,5,6,7,12,14,19,20,21)]。不但可製成中藥「淮山」，且可加工製成各種食品，以利外銷[(13)]。

近年來山藥已成爲本省外銷新興經濟作物之一，除供國內需要外，亦供外銷。山藥多植於旱田缺水的地方，而覆蓋不但可以減少土壤水分之蒸發[(10,15,18)]，同時可預防雜草之繁殖，使土壤中的水分，養分能充分的供給山藥之利用[(11)]，經試驗結果顯示以黑色塑膠布覆蓋最佳，與不覆蓋相較產量可增收 375 %[(11)]。致於有關支架方面之研究，據邱年永（1971 及 1973）指出，設支架能使日光對葉片之照射量增加，有益光合作用，促進地下塊根之肥大，增加塊根的數目及重量[(6,7)]。又據依澤凡人（1963）等及林樂健（1950）研究，設立支架的效果與上述同[(3,10)]。本試驗目的係以探討不同支架型式對山藥產量及品質之影響，以提高山藥單位面積之產量以及品質，增加其利用價值，以發展山藥外銷事業。

材料及方法

本試驗係以山藥（*Dioscorea alata* L.）瓶仔薯爲供試材料。支架型式爲 A. 6 尺高高支架

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1. 臺灣省農業試驗所 研究報告 第 1013 號。本研究承蒙本所農藝系主任謝博士順景之鼓勵與指導，文中統計蒙劉清博士於百忙中予分析，文成後並蒙指正，謹此申謝。

2. 本所農藝系助理。臺灣省 臺中縣 霧峰鄉。

、B. 4尺半高中支架、C. 3尺高矮支架及 D. 3尺高半弧形支架及 E. 對照（黑色塑膠布覆蓋）等五種處理。

試驗設計採用逢機完全區集法，5處理，4重複，每小區面積 380 cm×80 cm，株距 30 cm，植 12 株，整地作畦，按設計覆黑色塑膠布及立各種不同之支架，掘穴種植薯苗。調查項目計有株高、節數、分蘖數、莖葉乾重量、根徑、根長、塊根數目及重量。蛋白質分析係以山藥塊根烘乾磨粉後，採用 Semi-micro-kjeldahl 法測定含氮量，再乘以 6.25 即爲蛋白質含量[12,13,16,17]。

結果及討論

一、不同支架型式對山藥農藝性狀之影響

就株高而言，對各種處理山藥初期生育有顯著之差異，經變方分析結果各處理對株高之影響呈極顯著（表1）。惟對照區（黑色塑膠布處理區）生育有較慢之趨勢，其株高比4 尺半高中支架及 3 尺高半弧形支架處理者低 42 cm；其他各處理差異的影響不大。

表 1. 不同支架型式對山藥農藝性狀及根含蛋白質之影響

Table 1. Effects of different staking methods on agronomic characters and protein content of root in *Dioscorea alata* L.

處理 Treatment	株高 Plant ht. (cm)	節數 No. of nodes per plant	分蘖數 No. of tillers per plant	莖葉乾重 Dry wt. of stem leaf (kg/plant)	塊根數 No. of tuberous root per plant	鮮根產量 Fresh yield of tuberous root (kg/plant)	根徑 Diameter of root (cm)	根長 Length of root (cm)	蛋白質含量 Protein content (%)	塊根乾燥率 Percentage of dry root (%)
F 值 F Value	9.54**[a]	8.57**	3.5*	0.68	7.21**	1.07	0.70	3.26*	1.31	1.71
A. （高支架6尺） High Λ-type staking (6 feet)	58 a[b]	8.7 a	1.9 a	0.143	2.1 b	0.616	7.4	17.8 a	13.70	27.40
B. （中支架4尺半） Middle Λ-type staking (4.5feet)	65 a	9.6 a	1.5 b	0.108	1.7 c	0.472	6.8	16.6 a	11.20	27.33
C. （矮支架3尺） Low Λ-type staking (3feet)	57 a	9.1 a	1.8 a	0.111	1.7 c	0.450	6.5	18.6 a	11.30	26.09
D. （半弧形支架3尺） Arc type staking (3feet)	65 a	10.0 a	2.0 a	0.116	1.7 c	0.513	6.6	15.3 b	11.70	26.61
E. （黑色塑膠布） Black plastic film (CK)	23 b	5.4 b	2.2 a	0.105	2.5 a	0.462	6.1	14.7 c	10.87	28.91

a. *, ** Significant at 5% and 1% level respectively.

b. Number followed by the same letter are not significantly different at 5% level by Ducan's multiple range test.

生育初期之節數以 3 尺高半弧形支架處理區爲最多，平均 10 節，而以對照區最少，平均 5.4 節，各處理間差異極顯著（表1）。山藥初期生育分蘖數以對照區最多，平均 2.2 支，而以4尺半中支架處理爲最少，平均只有 1.5 支，處理間呈顯著差異（表1）。

地上部乾莖葉重量以高支架（6尺）處理產量最高，每株平均達 0.143 kg，對照區最低，每

株平均只有 0.105 kg。經變方分析結果各處理間差異呈不顯著（表1）。由資料顯示， 在各種不同支架型式處理不可提高莖葉重量，惟以高支架（6尺）處理下對促進地上部之發育效果尤佳。

塊根數以對照區最多，每株平均塊根數可達 2.5 個，高支架（6尺）處理者次之，達 2.1 個，而以中支架（4尺半），矮支架（3尺）及半弧形支架（3尺）處理為最少， 只有 1.7 個，顯示由於不同支架型式處理山藥而發生之差異，經變方分析結果呈極顯著（表1）。

塊根鮮重量（表1），以高支架（6尺）處理區最高，平均塊根鮮重量可達 0.616 kg，半弧形支架（3尺）處理區次之，平均每株 0.513 kg，矮支架（3尺）處理區最低，平均只有 0.45 kg，對

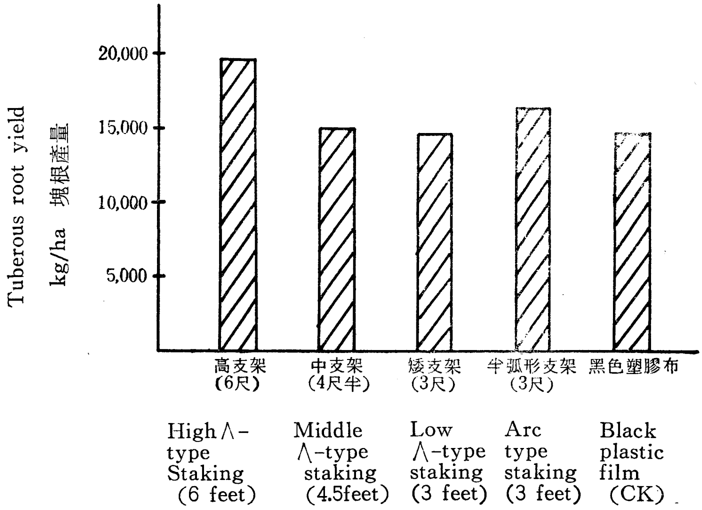

圖 1. 不同支架式對山藥塊根產量之影響

Fig. 1. Effect of different staking methods on the tuberous root yield of Dioscorea alata L.

照區為次低平均每株亦只有 0.462 kg。換算每單位面積最高產量為高支架（6尺）處理區 19712 kg/ha 比對照區增加 33%（圖1），但經變方分析結果各種處理間差異呈不顯著，此係因支架型式間之影響不大，由於支架型式不同影響到山藥光合作用之强弱，高支架有利於山藥光合作用，低支架則對山藥光合作用較差，因此利用高支架（6尺）處理可能有利於塊根之肥大，產量較高。

二、不同支架型式對山藥薯形及品質之影響

據表1根徑調查言，以高支架（6尺）處理區為最大，平均達 7.4 cm，中支架（4尺半）處理區次之，平均達 6.8 cm，而以對照（黑色塑膠布覆蓋）區為最小，平均只有 6.1 cm，經變方分析結果（表1）各處理間差異呈不顯著。根長言，由表1分析，以矮支架（3尺）處理區為最長，平均達 18.6 cm，高支架（6尺）處理次之，平均達 17.8 cm，而以對照（黑色塑膠布覆蓋）區為最短，平均只有 14.7cm，經變方分析結果（表1）各處理間差異呈顯著（表1），依根徑、根長測定薯形，以高支架（6尺）處理為最佳。

山藥塊根中蛋白質含量以高支架（6尺）處理區為最高，平均可達 13.7 %，半弧形支架（3尺）處理區次之，平均達 11.7 %，而以對照區最低，平均只有 10.87 %，但經變方分析結果各處理間差異呈不顯著（表1）。山藥塊根乾燥率以對照區為最高，平均達 28.91 %， 高支架（6尺）處理區次之，平均達 27.4 %，而以矮支架（3尺）處理區為最低，平均只有 26.09 %， 經變方分析結果各處理差異呈不顯著（表1）。

三、不同支架型式對山藥農藝性狀與產量之相關關係

由表 2 可知根長、乾燥率均與鮮根產量呈顯著正相關，其他如株高、節數、分蘗數、乾莖葉重、塊根數、根徑、蛋白質含量之關係不顯蓋。

四、不同支架型式對山藥農藝性狀塊根產量與蛋白質含量之互相間的相關

由表 2，株高與節數，節數與乾莖葉重，分蘗數與塊根數、蛋白質含量，乾莖葉重與蛋白質含量呈極顯著正相關。分蘗數與根長，蛋白質含量與乾燥率呈極顯著負相關。株高與乾莖葉重，節數與蛋白質含量，塊根數與蛋白質含量，鮮根產量與根長、乾燥率，根徑與含白質含量呈顯著正相關。株高與塊根數，節數與乾燥率，塊根數與根長，根長與蛋白質含量呈顯著負相關，其他均呈不相關。

總之，在山藥生育初期不同支架型式較對照區在株高、節數、分蘗數、塊根數、根長，有顯著的增加，故利用支架初期有助於山藥之生長，且可增加葉面行光合作用之速率。同時對塊根數及根長有

表 2. 山藥農藝性狀塊根產量與蛋白質含量之互相間的相關

Table 2. Correlation between agronomic characters, yield and protein content of tuberous roots of *Dioscorea alata* L.

項目 Items	節數 (×2) No. of nodes	分蘗數 (×3) No. of tillers	乾莖葉重 (×4) Dry wt. of Stemleaf	塊根數 (×5) No. of tuberous root	鮮根產量 (×6) Fresh yield of tuberous root	根徑 (×7) Diameter of root	根長 (×8) Length of root	蛋白質含量 (×9) Protein content	塊根乾燥率 (×10) Dry Percentage
株高 Plant ht. (×1)	0.9801**	- 0.0822	0.5601*	- 0.4457*	0.1337	0.2839	- 0.0288	0.3992	- 0.4262
節數 (×2) No. of nodes		0.024	0.5646**	- 0.3516	0.051	0.3262	-0.138	0.4755*	- 0.5388*
分蘗數 (×3) No. of tillers			0.4188	0.6955**	- 0.2151	0.1691	-0.6212**	0.6401**	- 0.4364
莖葉乾重 (×4) Dry wt. of stem leaf				0.2678	0.3018	0.2804	- 0.2663	0.641**	- 0.18 01
塊根數 (×5) No. of tuberous root					- 0.0459	0.3417	- 0.4640*	0.5084*	- 0.1402
鮮根產量 (×6) Fresh yield of tuberous root						0.3666	0.5404*	- 0.1594	0.5274*
根徑 (×7) Diameter of root							0.0111	0.5565*	- 0.3394
根長 (×8) Length of root								- 0.4823*	0.4408
蛋白質含量 (×9) Protein content									-0.6752**

益，但在乾莖葉重量、鮮根產量、根徑、 protein 含量、塊根乾燥率無顯著的影響，由於乾莖葉重量不顯著，因而影響到鮮根產量，因二者互爲因果，據作著於 1979 年研究有關覆蓋物對山藥質量之影響，謂乾莖葉產量與鮮根產量有成正比之趨勢，此點與本研究結果略似。山藥係旱地作物，但在生育期中需有充分之水分及陽光，而塊根之形成以及蛋白質含量之提高非有旺盛之光合作用不可，而不同支架型式較黑色塑膠布處理可能有助於山藥產量及品質，由於山藥品種繁多，並在本省各地發現野生優良品種數種以及引進國外優良品種予綜合觀察，其結果選出數種優良品種，有關此項須待進一步研究。

參考文獻

1. 甘偉松・1971・藥用植物學：627-635・國立中國醫藥研究所出版。
2. 那 琦・1965・臺灣產山藥之生藥學研究：1-84。
3. 那 琦、鄭炳全・1967・臺灣產山藥之生藥學研究補遺，北醫自然會會刊（6）：46-72。
4. 那 琦、蔡理里・1969・臺灣產山藥之生藥學研究補遺之二。北醫自然會會刊（8）：48-56。
5. 那 琦、東丈夫、岡西為人・1958・東北之藥材（上册）：34-72・國立中國醫藥研究所出版。
6. 邱年永・1971・山藥的栽培與加工・新醫潮期刊：83-88・中國醫藥學院出版。
7. 邱年永・1973・藥用植物栽培法：415-424・大學圖書出版社。
8. 林樂健・1950・支柱不同方式對菜豆產量之影響。農業研究 1（2）：26-30。
9. 孫星衍、孫馮翼、清・1891・神農本草經：52-76・自由出版社重刊（1958）。
10. 徐原田、楊永裕・1975・不同遮蔭覆蓋對人參產量及品質影響之研究・科學農業 23(5-6)：258-261。
11. 徐原田・1979・不同覆蓋對山藥產量及品質影響之研究・中華農業研究 28(2)：117-123。
12. 許鴻源・1968・中藥成分最近的研究：180-181・國立中國醫藥研究所出版。
13. 許鴻源・1972・臺灣地區中藥材圖鑑：35-163・行政院衛生署中醫藥委員會出版。
14. 許喬木・1960・臺灣藥用植物成分Ｉ：12-60・國立中國醫藥研究所出版。
15. 楊永裕・1968・不同覆蓋物與施肥量對檸檬草油分之影響・農業研究 17(4)：47～50。
16. 顏焜熒・1968・植物化學：5-40・國立中國醫藥研究所出版。
17. 蘇仲卿・1974・作物品質及其測定技術・旱地糧食作物改進講習會專刊：113-117・臺灣農業研究中心。
18. 嚴夢如等・1966・柑桔遮蔭試驗・農業研究15(1)：26-35。
19. 日本公定書協會編・1971・新しい藥用植物栽培法：400・廣川書店。
20. 伊澤凡人，三宅壽夫，田中孝治，藤森正久・1963・これからの藥草栽培と採用：361-368・アヅ書房刊。
21. F. W. Martin, & A. M. Rhddes, 1977. Intra-Specific classification of *Dioscorea alata*. Trop. Agric. (Trinidad) 54(1): 1-13.

Effect of different staking methods on the quality and yield of *Dioscorea alata* L.[1]

Y. T. Shyu[2]

Summary

For studying the effect of staking types on the yield and quality of *Dioscorea alata* L., high Λ-type staking (6 feet), middle Λ-type staking (4.5 feet), low Λ-type staking (3 feet), arc type staking (3 feet) and control (non-staking) were used. Arc type staking was the best on plant height, no. of internodes and no. of tillages for plant growth stage but was for tuber root growth stage. Staking showed an advantage on plant and tuber root growth by increasing plant dry weight, yield, protein content and Shape of tuber root. High staking increased 33% (4928 kg/ha) in tuber root yield, 36% in dry weight of upper part, and 2.83% in protein content compared with non-staking. Whereas, arc type staking increased 11% (1632 kg/ha) in tuber root yield, 10% in dry eight of upper part, and 0.83% in protein content compared with non-staking.

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Studies on chromosomal translocation in *Haworthia*[1]

Min-syang Chen[2]

Abstract : The normal karyotype of most species of the tribe Aloineae comprises 8 long and 6 short chromosomes. It was observed that in a diploid plant of *Haworthia attenuata* var. *britteniana* f. V. Poelln., there occured a simple translocation between the L_4 and L_2 chromosomes. The detailed description is $K=2n=8L+6S=2L_1+1L_2+1L_T+2L_3+1L_4+1L_D+2S_1+2S_2+2S_3$. Among the 337 cells examined at meiosis, the quadrivalent chromosomes involving translocation in the form of $(1L_2+1L_T)$ and $(1L_4+1L_D)$ was observed in 285 cells, pairings of either $(1L_2+1L_T)$ or $(1L_4+1L_D)$ to form bivalents were found in 48 cells, and other chromosome pairings were observed in 4 cells. Pollen grains appeared to be 50% viable.

The normal karyotype of most species of the tribe Aloineae comprises 8 long and 6 short chromosomes [10,11,16]. Hexaploid and octoploid plants of *Haworthia* have been detected with chromosomal aberrations : they bear a simple translocation accompanied by other complex structural abnormalities, and deletion, respectively. The somatic chromosome studies of these two plants have been published [4,5,6]. Recently, a diploid plant of *Haworthia* was found to bear simple translocation. Although some plants of Aloineae had previously been studied [1,2,13,14], this plant was the first reported with karyotype analysis. In order to detect the chromosomal behavior, detailed cytogenetical studies have been made on this abnormal plant, a diploid plant (2x=14) of *H. attenuata* var. *britteniana* f. (68-083-222).

Material and Method

Plants of *H. attenuate* var. *britteniana* f. was obtained from the Izu Natural History Park, Shizoka, Japan. It was originally from South Africa where the genera are indigenous. Root tips were collected for study of somatic chromosome behavior. The squash technique is as follows : (1) as pretreatment, root tips were treated for 2 hours in 0.002 M 8-oxyquinoline at 18°C-20°C ; (2) fixed in Carnoy's solution (3 : 1) for 24 hours ; (3)

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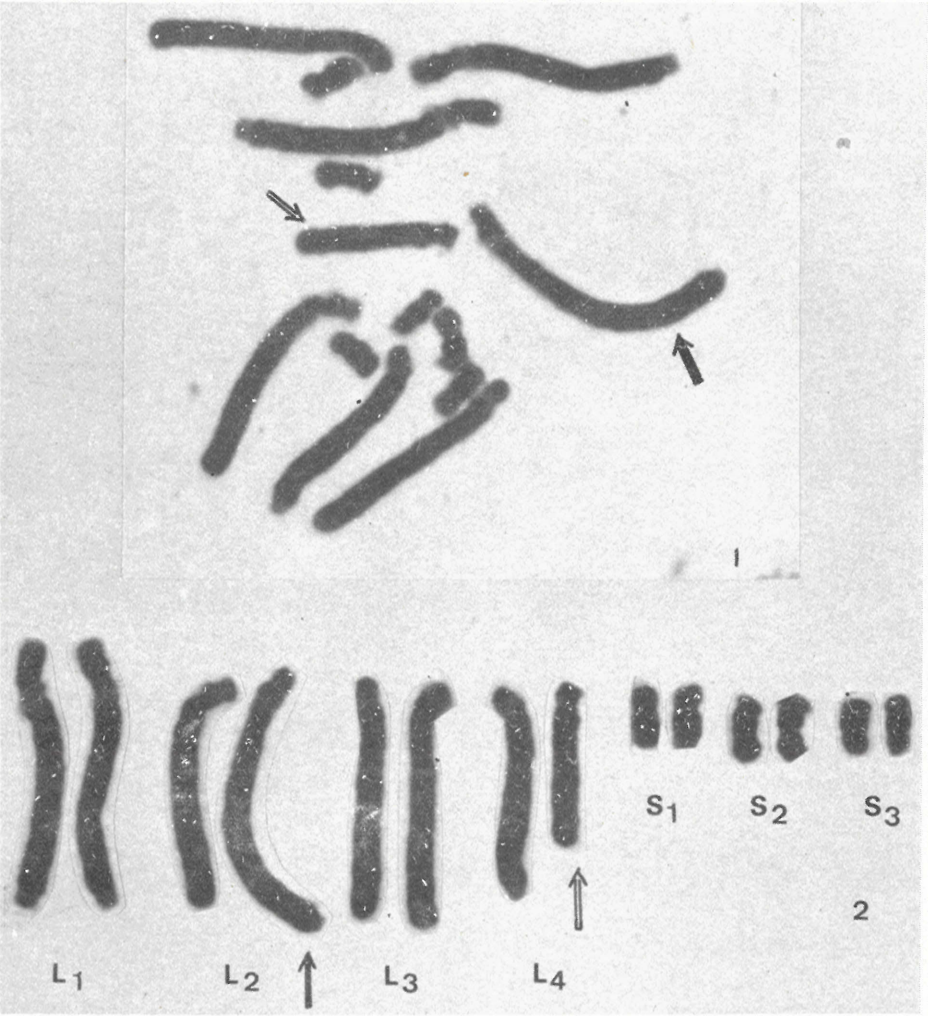
hydrolyzed in 1N-HCl for 6 minutes at 60°C ; (4) stained in feülgen solution ; (5) finally they were squashed in aceto-carmine. Pollen fertility and sterility were detected after staining the pollen grains in acetocarmine-glycerin jelly (1 : 1).

Results aud Discussion

H. attenuata var. *britteniana* f. (68-083-222)

Leafy stem, rosette ; leaves green, becoming reddish with age, acuminate, the tip dries before the leaf becomes fully mature, 40-50mm. long, 9-12mm. wide at the base, back with white tubercles arranged in regular transverse bands, keeled from the middle to the



Figs. 1-2. *H. attenuata* var. *britteniana* f. (68-083-222), 2n=8L+6S=14.

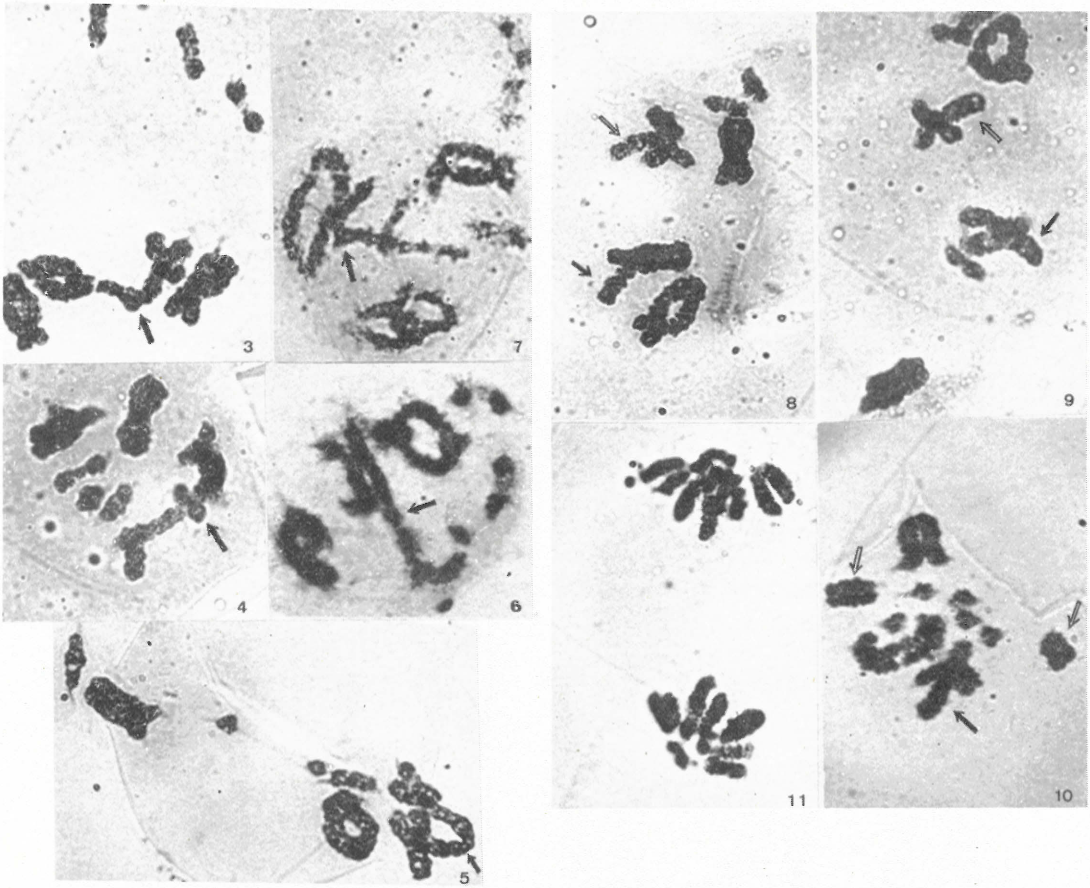
Fig. 1. Somatic metaphase with 2n=8L+6 S=14 chromosomes. The arrows indicate the long translocation chromosomes. **Fig. 2.** Karyotype. The arrows indicate the long translocation chromosomes.

tip, margins with white teeth [8].

Peduncle branched, to about 45cm. long ; pedicels 4mm. long ; bracts 3-4mm. long ; perianth white-greenish, with green-brownish lines, 11-12mm. long [8].

According to John [9], "*Haworthia attenuata* var. *britteniana* Von Poelln. is variable, but is characterized by a thick encrustation of white tubercles. On the back of the leaf they tend to come in two size, the larger loosely arranged in band across the leaf, the smaller in random clusters between them ; the upper surface is covered with small tubercles giving the appearance of frosting."

The plant is a diploid and bears a simple translocation ($K=2n=8L+6S=2L_1+1L'_2+$



Figs. 3-11. *H. attenuata* var. *britteniana* f. (68-083-222).

Figs. 3-5. Meiotic metaphase I showing $1IV\ [(1L_2+1L_T)+(1L_4+1L_D)]+2II(L)+3II(S)$. The arrows indicate the long translocation chromosomes. **Figs. 6-7.** Late diakinesis. **Figs. 8-9.** Meiotic metaphase I showing $2II(L)+2II(L)[(1L_2+1L_T),\ (1L_4+1L_D)]+3II(S)$. The arrows indicate the long translocation chromosomes. **Fig. 10.** Meiotic metaphase I showing $3II(L)+2I(L)\ (1L_4,\ 1L_D)+3II(S)$. The arrows indicate the long translocation chromosomes. **Fig. 11.** Anaphase I showing a normal separation.

$1L'_T+2L_3+1L_4+1L_D+2S_1+2S_2+2S_3$). Figures 1 and 2 reveal that one of the normal long chromosomes is of the L_4 type with a satellite at the end of the long arm. The five other normal long chromosomes are $2L_1$, $1L_2$ and $2L_3$. The interesting abnormal long chromosome is one L_4chromosome which has a long arm about one-third shorter than that of the normal L_4chromosome. One L_2 chromosome is noticeably longer than the other and has a satellite at the end of the long arm. Measurements of the length of the long arms of these two chromosomes were made and were compared with those of the translocated chromosomes. They are given in Fig. 12.

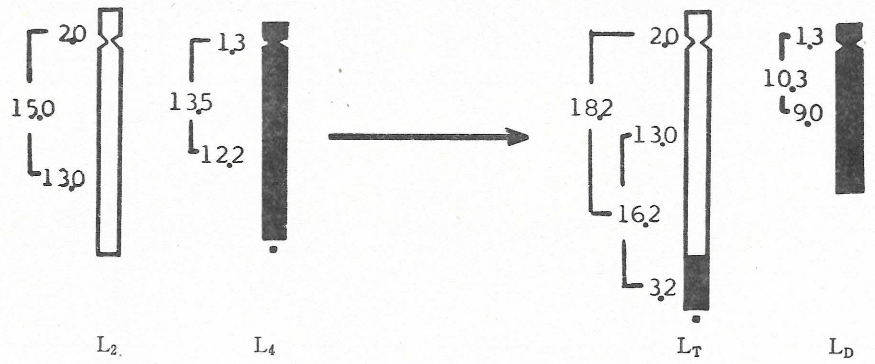


Fig. 12. A possible mechanism by which the translocated chromosomes could have arisen in *H. attenuata* var. *britteniana* f.

Apparently this interchange involves an L_4 and an L_2 chromosomes. It can be seen that a segment about one-third (3.2μ) the length of the long arm breaks at the end of one of the L_4 chromosomes and is translocated to the end of the long arm of one of

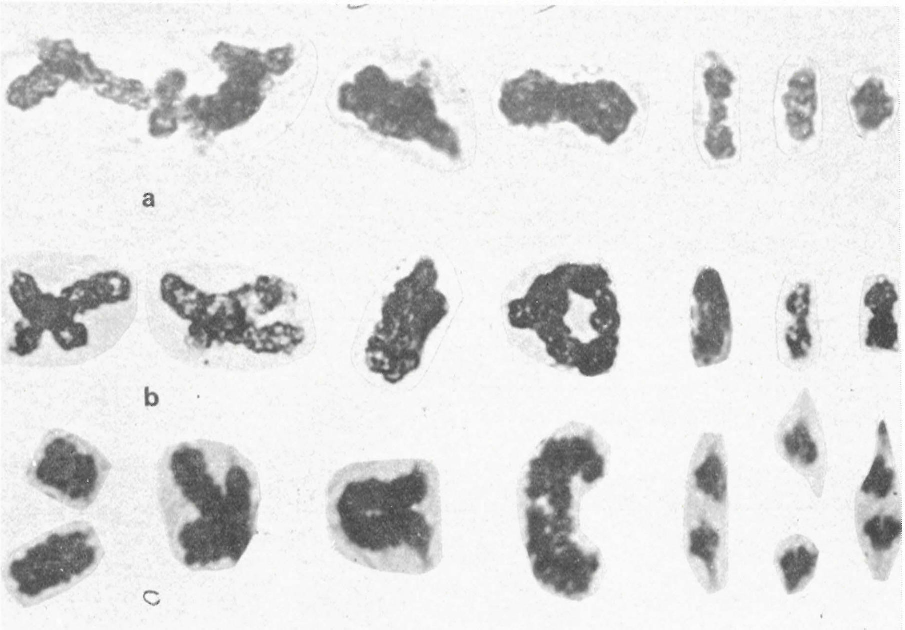


Fig. 13. Chromosome pairing at meiotic metaphase I in translocated *H. attenuata* var. *britteniana* f.

the L_2 chromosomes (Fig. 12). There is no break occurred at centromere as reported by Riley and his co-workers [13,14]. Although many diploid plants of the Aloineae had previously been studied [1,2,13,14,16], this was the first plant reported with this aberration.

Meiotic behavior is illustrated in Table 1. In the *Haworthia* plants studied so far the pachytene stage could not be analyzed [6,15]. Therefore the types of translocation configuration have to be identified by studying the late diakinesis (Figs. 6 and 7) and metaphase I stage of meiosis. Figure 13 shows the types of translocation association.

Table 1. Pairing associations at metaphase I of *H. attenuata* var. *britteniana* f. with translocations

Metaphase I configurations	No. of PMCs observed	
1Ⅳ(L) + 2Ⅱ(L) + 3Ⅱ (S)………………………………	285	(Figs. 3 - 5)
4Ⅱ (L)+ 3Ⅱ(S)………………………………………………	48	(Figs. 8 & 9)
2Ⅱ (L) +2Ⅰ (L) + 3Ⅱ (S)……………………………………	4	(Fig. 10)
Total	337	

The quadrivalent configurations involving ($1L_2+1L_T$) and ($1L_4+1L_D$) (Fig. 13-a) were seen in 285 cells; the pairings of either ($1L_2+1L_T$) or ($1L_4+1L_D$) to form bivalents were found in 48 cells (Fig. 13-b); and in 4 cells the ($1L_4$, $1L_D$) chromosomes were unpaired to form two univalents and the ($1L_2+1L_T$) chromosomes were paired to form bivalent configurations (Fig. 13-c).

In 337 cells, the long chromosomes were arranged in 285 quadrivalents, 774 bivalents and 8 univalents. The short chromosomes were arranged in 1,053 bivalents.

At anaphase of the microspore division, 18.2% of the cells had irregularities consisting of chromatin bridges, bridges and fragments. Of the 530 "tetrads" studied, there were one one-cell "tetrads", five three-cell "tetrads", two five-cell "tetrads", and 522 four-cell "tetrads".

Table 2. Characteristics of microspore anaphase and pollen of the diploid simple translocation

Stages	Characteristics	No. observed	Percentage (%)
Microspore	Chromatin bridges, bridges and fragments	10	18.2
anaphase	Regular	45	81.8
	Total	55	
Pollen	Shriveled, unstained, and apparently sterile	367	49.8
	Stained and apparently fertile	370	50.2
	Total	737	

Acetocarmine squashes of mature pollen grains showed that 50.2% were stained and appeared to be normal, and the remaining 49.8% were shriveled, unstained and apparently sterile. Pollens appeared to be 50% viable according to Brink [3] in his report on chromosome translocations in Maize.

Translocation in *H. attenuata* var. *britteniana* f. is a simple translocation. In *Haworthia*, such a translocation has been detected so far in only this plant reported here which is a translocation heterozygote. In maize, alternate and adjacent types occur with equal frequency and, as the latter produce inviable gamete, pollens of the plant heterozygous with such a translocation are about 50% sterile [3]. The plant reported in this paper strongly resembles the maize plant. Interchange occurs between chromosomes L_2 and L_4.

Reference

1. Brandham, P. E. 1969. Chromosome behaviour in the *Aloineae* II. The frequency of interchange heterozygosity. Chromosoma 27 : 216-225.
2. Brandham, P. E. 1975. Stabilised breakage of a duplicated chromosome segment in *Aloe*. Chromosoma 51(3) : 269-278.
3. Brink, R. A. 1927. The occurrence of semi-sterility in Maize. J. Heredity 18 : 266-269.
4. Chen, M. S. and Kondo, N. 1972. Chromosome studies on *Haworthia tessellata*. LA Kromosomo 88-89 : 2815.
5. Chen, M. S. and Kondo, N. 1973. Chromosome studies on the genus of *Astroloba*. LA Kromosomo 92-93 : 2917.
6. Chen, M. S. 1974 Cytogenetic studies on the genus *Haworthia* and its allied genera. Ph. D. dissertation, Tokyo Uni. of Agriculture, Tokyo.
7. Jacobsen, H. 1960. A handbook of succulent plants. : 538-539. London : Blandford Press.
8. John, W. P. 1970. The first fifty *Haworthias*. The succulent plant Institute, England : 11.
9. Kondo, N. and Megata, M. 1943. Chromosome studies in *Aloineae*. Seiken Ziho 2 : 69-82.
10. Mukerjee, D. and Rily, H. P. 1961. Karyotype analysis of *Haworthia* species and varieties with special reference to the satellite chromosomes. Genetics 46 : 885.
11. Riley, H. P., Majumdar, S. K. and Hammack, R. E. 1967. Chromosomal translocations in three plants of the genus *Haworthia*. Canad. J. Genet Cytol. 9 : 683-690.
12. Riley, H. P. and Majumdar, S. K. 1968. Three new chromosomal translocations in *Haworthia*. Canad. J. Genet. Cytol. 10 : 487-494.
13. Riley, H. P. and Majumdar, S. K. and Hammack, R. E. 1969. Meiosis in a triploid *Haworthia*. J. Heredity 53 : 105-109.
14. Sato, D. 1942. Karyotype alteration and Phylogeny in Liliaceae and allied families. Jap. J. Bot. 12 : 57-161.

Haworthia 屬植物染色體轉座現象之研究[1]

陳 敏 祥[2]

中文摘要

百合科 Aloineae 族植物之染色體爲典型之 "Bimodal" 核型，即有 8 個大型染色體與 6 個小型染色體 (8L+6S). *Haworthia* 屬中之 *H. attenuata* var. *britteniana* f. V. Poelln. 爲 2 倍體，核型分析結果，在 L_2 與 L_4 染色體上產生單轉座現象，其核型爲 $K=2n=8L+6S=2L_1+1L_2+1L_T+2L_3+1L_4+1L_D+2S_1+2S_2+2S_3$，減數分裂顯示，在 337個細胞中，兩組相同染色體各相配對且其單向轉座部份之染色體對合成Ⅳ價者，有 285 個細胞；相同染色體配對成Ⅱ價，而轉座部分不相對合者，有48個細胞；其他者有 4 個細胞，花粉稔性僅 50%。

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Low temperature treatment and flower development in Ta-Mei-Fua radish[1]

Tzay Fa Sheen[2]

Abstract : A seed vernalizing type of radish was used to find a method to promote flowering in late bolting radish for breeding in the tropics. The relationship between morphological changes of the shoot apex and metabolic changes in nitrogen, carbohydrates compounds during flower development was also investigated.

Results indicated that mature Ta-Mei-Fua radish will flower when defoliated of top parts and the root is exposed to 9±1°C temperatures and 16 hr daylight for three weeks.

The number of tunica layers on the shoot apex increased from 4-5 layers to 5-6 layers when mature plants were exposed to three weeks of low temperature treatment. The number of layers decreased rapidly to three layers when mature plants transited from the generative stage to the reproductive stage. At the same time, cell shapes on the corpus layers changed from their original flat type to an erect swollen type. The flower primordium began to form after four weeks of low temperature treatment. Sugar content increased during low temperature treatments and was highest when cell division on the shoot apex was at a maximum and the tunica layers were increasing to 5-6 layers. Sugar content gradually decreased as the number of tunica layers decreased to three and flower primordium formation gave way to bolting. Changes in sugar contents were similar to those of mature green vernalization type crops when treated with low temperatures.

Cultivar Ta-Mei-Fua is one of the major radish cultivars planted during the autumn and spring cropping seasons in Taiwan. When this crop is planted in northern Taiwan or at high altitudes, low temperatures cause premature bolting, reducing both yields and quality for fresh market production. Seed production, on the other hand, suffers from insufficiently low temperatures to induce bolting and flowering of selected seed mother plants. Therefore, methods for preventing premature bolting of an economic crop in early or late winter and artifically inducing flowering of the seed mother plant for breeding work need to be devised.

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Radish is a seed vernalization type crop. A number of studies have indicated that low temperature treatments on germinating seeds are effective in accelerating flowering in radish. Yamato[20] showed a relationship between low temperature and the flowering response of a germinating radish seed. Eguchi[2] demonstrated that radish flowering was promoted when germinating seeds were exposed to 5°C temperatures for 15-20 days. Kagawa[6] showed that germinating seeds treated with low temperatures and sufficient light had a better flowering response than seeds treated with low temperature under total darkness. Sugiyama[17] showed differences in the flowering habits of several radish varieties and used these differences to classify the radishes. Shinohara[16] examined the genealogical and population genetic aspects of phasic development and classified the climatypes of radish. While these research on flowering physiology and morphogenesis of radish may also be applicable to the tropics and subtropics, no methods have been devised to promote flowering of selected seed mother plants under warm temperature conditions.

Seed mother plants were therefore selected to evaluate radish flowering behavior. All selected radish plants were exposed to low temperature conditions. Results from preliminary experiments indicated that radish roots appeared to vernalize efficiently when packed in transparent plastic bags and expose to light and longer low temperature treatments. The experiment investigated the morphological changes in the shoot apex and changes in nitrogen and carbohydrate compounds in the root during flower development. The morphological and histochemical changes of the mature root of a seed vernalizing plant type was also studied.

Materials and Methods

Radish cv. Ta-Mei-Fua was sown on October 17, 1980 and harvested on November 25, 1980. Plants were selected for the experiment at harvest according to size and uniformity. The leaf blades of all selected plants were cut to 1/3 height, and then 2-3 plants were packed together in 0.02mm transparent plastic bags for treatments at 9 ± 1°C and 16 hr daylight. Each week, 25 plants were moved from the cold room. Twenty of these were transplanted to the field for observations on flowering response and the remaining five plants were used for analysis. This work continued every week for four weeks. A check plot was maintained in the field. On January 5, 1981, individual plants from each treatment were taken as samples. For all samples the shoot tip was fixed in a solution of formalin, alcohol and acetic acid (1 : 8 : 1). After dehydration and paraffin embeded, the tissue samples sliced into 12-15mm sections and stained with Ehrlich's Hematoxylin for anatomical observation. Root parts were dried in the oven at 60°C for nitrogen and carbohydrate analysis. Nitrogen was analyzed by the Kieldahl method. Soluble sugar and starch were analyzed by the Anthrone method and reducing sugar by the Somogi method. A flow chart of the experimental design is shown in Figure 1.

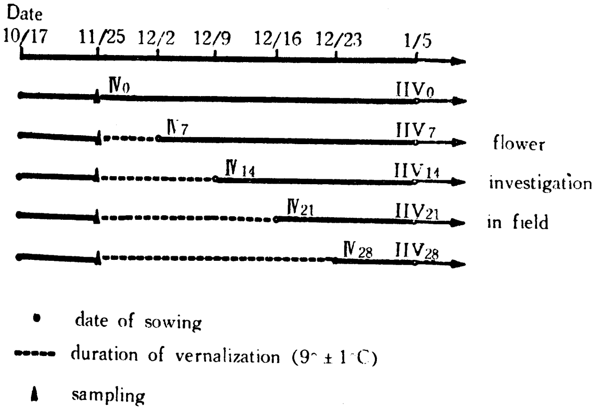

Fig. 1. Experimental plan for vernalization Ta-Mei-Fua radish.

Results and Discussion

Changes in the dry matter content the radish root after being exposed to low temperature treatments and transplanted to the field are shown in Table 1. Although new leaves continued to grow during the low temperature treatment, dry matter of the treated plots was less than that of the check, probably due to insufficient light exposure and lack of nutrient supply. Dry matter accumulation increased, however, after transplanting to the field.

Table 1. Dry matter (%) of radish root after vernalization

Treatment	%	Treatment	%
IV 0	5.9	IIV 0	5.5
IV 7	5.1	IIV 7	5.8
IV 14	5.3	IIV 14	6.4
IV 21	5.3	IIV 21	6.4
IV 28	5.5	IIV 28	6.2

Table 2. Changes in tunica layers of the shoot apex after low temperature treatment

Treatment	No. of plants examined	No. of tunica layers			Plants of floral primordia initated
		4-5	5-6	3	
IV 0	5	5			0
IV 7	5	4	1		0
IV 14	5	3	2		0
IV 21	5	1	3	1	0
IV 28	5		3	2	1

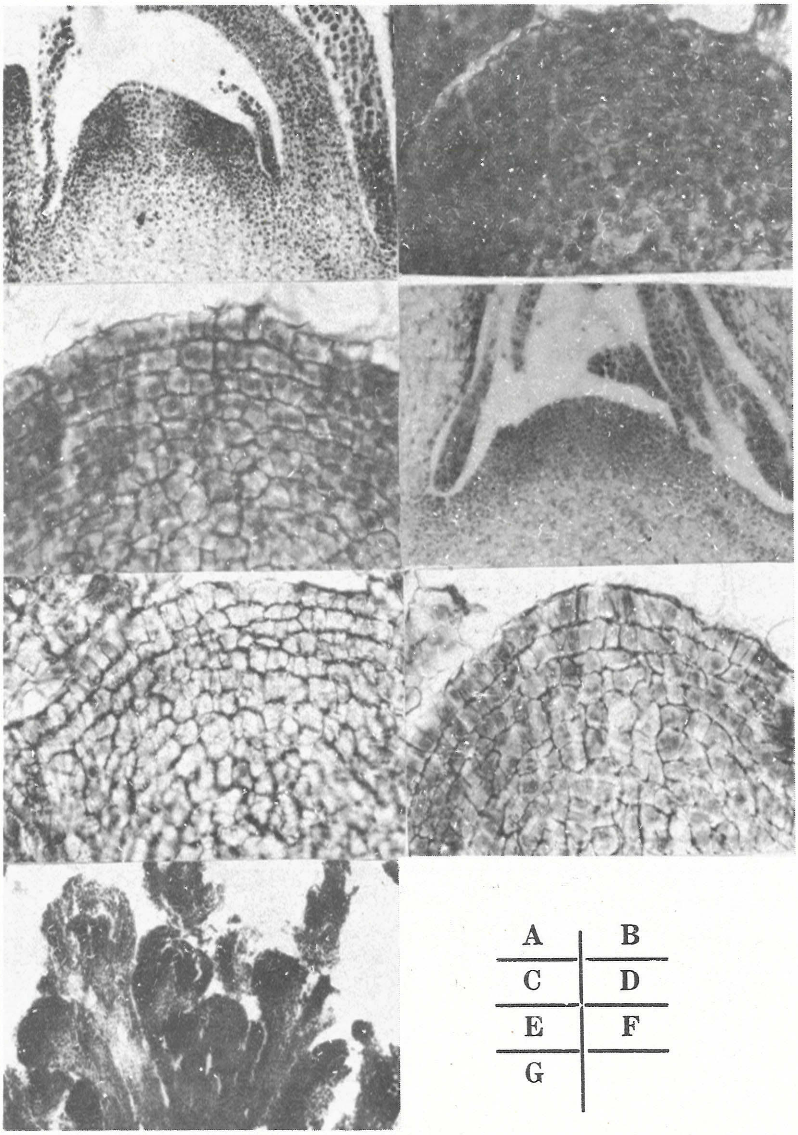

Fig. 2. Floral development of radish root treated with different durations of low temperatures. See Figure 1 for reference to the experimental plan.

A. Non-treated (IV 0) —Vegetative adult. 4—5 Tunica layers were observed. **B.** One week treated. (IV 7)—Vegetative stage is maintained ; 4—5 tunica layers were observed. The height of the apex increased and the top grew ellipsoid. **C.** Two weeks treated (IV 14)—The apex gradully grew taller and thicker. 5 tunica layers were observed. Cell division increased on the upper part of the corpus. **D.** Three weeks treated (IV 21)-6 tunica layers were observed. **E.** Four weeks treated (IV 28)-The tunica layers decreased to 3, the shoot apex was more elongated. The first floral primordium was initiated at the inner part of the apex. **F.** Observation on January 5 of the one week treatment (IIV 7).—The tunica layers decreased to 3 and many new cells accumulated on the upper part of the corpus. **G.** Observation on January 5 of the four week treatment (IIV 28)-Flower bud and sepal were formed.

Table 2 and Figure 2 show changes in the tunica layer of the shoot apex after low temperature treatments. The shoot apex growth of the check plants appeared flat and contained 4-5 tunica layers (IVO). After one week of low temperature treatments the shoot apex appeared oblong and still maintained 4-5 tunica layers (IV7). The height and thickness of the shoot apex increased after two weeks of low temperature treatments. The number of tunica layers increased to 5-6, and more cell division activity appeared on the growing point with many new cells accumulating on the upper part of the corpus layer. The tunica layers then entered a transitional phase (IV14, IV21). The shoot apex appeared taller and tunica layers decreased from the original 5-6 dayers to 3 layers after 3-4 weeks of low temperature treatments. At the same time, the cells of the corpus layer assumed a more swollen shape (IV21, IV28). Flower primordia were initiated on the shoot apex of one plant after four weeks of low temperature treatments (IV28). Plants planted to the field on January 5, 1981 after one week or two weeks of low temperature treatments showed some flower primodium differentiation, but the plants exposed to four weeks of low temperatures were already bolting (IIV28). Figure 3 illustrates the effects of different durations of low temperature treatments on flowering behavior. The plants exposed to low temperatures for three weeks were the first to flower on February 8. All of the low temperature treatments had at least some plants that flowered, while the non-treated check had no flowering plants. The plants exposed to low temperatures for three weeks demonstrated the fastest flowering rate.

Table 3 shows the changes in nitrogen and carbohydrate contents of radish roots. Total nitrogen did not change significantly, but soluble nitrogen tended to increase with peak after the first week of low temperature treatment. Accordingly, insoluble nitrogen tended to decrease, reaching a nadir after the first week. Total carbohydrates, total sugar, non-reducing and reducing sugar increased up until the third week of low temperature treatments after which they decreased. C/N and total sugar/N ratios were at a maximum after two weeks of low temperature treatments. Starch contents tended to decrease. After the plants were harvested for observation on January 5, 1981, the soluble nitrogen and sugar contents tended to be less than the levels during vernalization. The non-reducing sugar, total sugar and total carbohydrate contents were highest in the plants which had been exposed for three weeks of low temperatures (IIV21). Reducing sugar, non-reducing sugar and total sugar contents decreased when plants began to bolt after four weeks of low temperature treatment. Soluble nitrogen contents were higher the longer the low temperature treatments. Total nitrogen contents of all temperature treatments were lower than that of the check plot except the four-week treatment, indicating that plants began to absorb nitrogen when bolting, thus lowering both C/N and total sugar/N ratios.

Wang [19] examined that the number of tunica layers on the shoot apex of To-pe-tsai (*B. chinensis* L.) increased from 4-5 to 5-6 layers when the plant changed from the vegetative phase to the reproductive phase. This number rapidly decreased to 3 layers before the flower primordium was initiated. Radish was demonstrated the same phenomenon, with increasing sugar contents before flower bud differentiation. The sugar

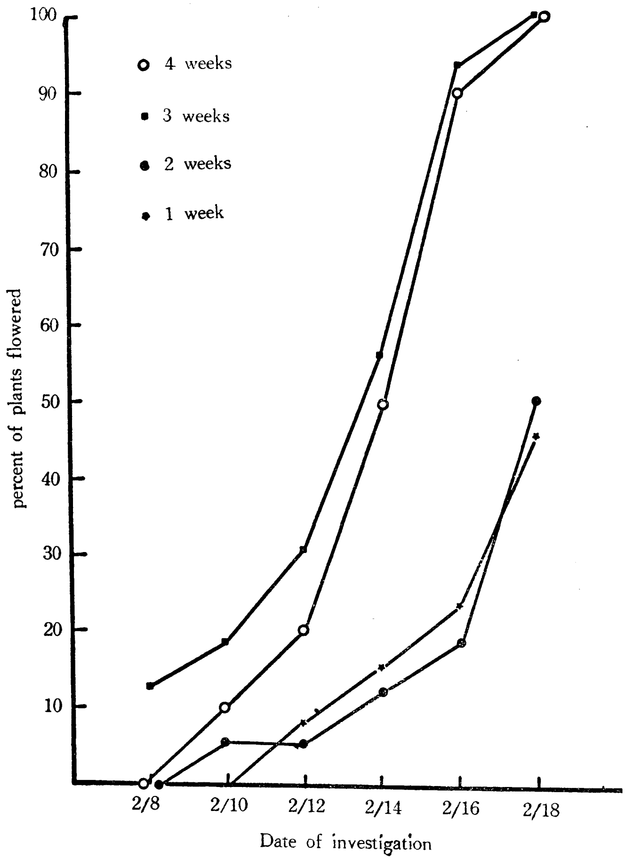

Fig. 3. Effect of different duratons of low temperature treatments (9±1°C) on the flowering behavior of Ta-Mei-Fua radish

Table 3. Changes in carbohydrate and nitrogen contents in radish root exposed to low temperatures for different duration (% dry matter)

Treatment	Nitrogen			Soluble sugar			Starch	Total carbo-hydrates	C/N	Total soluble sugar/N
	Soluble	Insoluble	Total	Reducing	Non-reducing	Total				
IV 0	1.24	1.49	2.73	21.3	14.1	35.4	7.4	42.8	15.7	13.0
IV 7	1.64	0.99	2.63	24.3	18.2	42.5	4.6	47.1	17.9	16.2
IV 14	1.39	1.17	2.56	24.4	18.7	43.1	3.8	46.9	18.3	16.8
IV 21	1.33	1.39	2.72	24.6	19.5	44.1	3.4	47.5	17.1	16.2
IV 28	1.34	1.29	2.63	23.3	17.5	40.8	2.0	42.8	16.3	15.5
IIV 0	0.98	2.14	3.12	19.5	5.9	25.4	2.2	27.6	8.8	8.1
IIV 7	1.10	1.50	2.60	17.4	9.5	26.9	4.6	31.5	12.1	10.3
IIV 14	1.18	1.71	2.89	19.9	13.2	33.1	4.8	37.9	13.1	11.4
IV 21	1.22	1.45	2.67	12.3	25.2	37.5	5.0	42.5	15.2	14.0
IV 28	1.46	1.71	3.17	13.4	14.5	27.9	6.4	34.3	10.8	8.8

content (Table 3) continued to increase as the tunica layers increased from 4-5 layers (Table 2, V14) to 5-6 layers (Table 2, IV21), and then gradually decreased (Table 2, IV28) as the tunica layers decreased to three layers. With the appearance of the flower primordium, the sugar content decreased even more (Table 3-2, IIV28), especially when plants began to bolt. This indicates that the cell division stage consumes more sugar, and that the increase and subsequent decrease in sugar contents were related not only to flower bud formation but to flower development and bolting as well.

The decrease in starch contents and increase in reducing sugar, non-reducing sugar and total sugar contents during flower bud differentiation were the same as reported by Suzuki [18] for cabbage. The results were similar also to results from previous research on the efficiency of low temperature treatments on mature kohlrabi, and showed that flower bud formation in radish increased sugar contents during vernalization. Sugar contents gradually decreased from flower primordium development to bolting. At the same time, the C/N ratio tended to decrease due to the absorption of nitrogen by the plant during bolting. Therefore, the low temperature response of flower bud differentiation was an increses in suger content, with the total sugar/N ratio reaching a peak just before flower bud differentiation. When the plants passed into the reproductive or bolting stage, sugar contents decreased and nitrogen was absorbed by the plant decreasing both the total sugar/N and C/N ratios. This pattern of metabolic changes during flower development in radish the same as demonstrated in previous research on kohlrabi (Sheen). [14]

Literature cited

1. Edward, J. T. 1966. Metabolic changes associated with vernalization of wheat. I. Carbohydrate and nitrogen patterns. Plant Physiol. 41 : 277-281.
2. Eguchi, T. and M. Koide. 1944. On the time of flower bud differentiation related to sowing-time and the effect of varnalization in *Raphnus* and *Brassica* vegetables. J. Jap. Soc. Hort. 15 (1) : 1-27. (In Japanese with English summary).
3. Eguchi, T., T. Matsumura, and T. Koyama. 1936. The effect of low temperature on flower and seed formation in Japanese radish and Chinese cabbage. Proc. Amer. Soc. Hort. Sci. 82 : 3 22-331.
4. Iwasaki, F. 1969. Studies on bolting in Brassica. V. Morphological and histochemical changes of the shoot apex during vernalization. J. Jap. Soc. Hort. Sci. 38 : 39-42. (In Japanese with English summary).
5. Kagawa, A. 1955. Studies on the effect of low temperature induction in radish plant. I. Studies on the transmission of thermo inducing stimulus and the effect of removing cotyledon upon the flowering induction of Japanese radish. Bull. Nat. Inst. Agr. Sci 'Jap. Ser. E4 : 265-280.
6. Kagawa, A. 1957. Studies on the effect of low temperature in radish plant. II. Res. Bull. Fac. Agr. Gifu Uni. 8 : 57-66. (In Japanese with English summary).
7. Kimura, K. 1961. Effect of temperature and nutrient on flower initiation of *Raphanus sativus* L. in total darkness. Bot. Mag. Tokyo 74 : 361-8.
8. Kraus, E. J. and H. A. Kraybill. 1918. Vegetation and reproduction with special reference to tomatoes. Oregon Agr. Coll. Exp. Sta. Bull. 149 : 1-90.

9. Kruzhilin, A. and Z. M. Shvedskaya. 1957a. Changes in sugar content during the vernalization of biennial plants. Doklady akad. mauk. S. S. S. R. 116 : 870-3.

10. Lysenko, T. D. 1935. The theoretical principles of vernalization. Agrobiology 9-64.

11. Platenius, H. 1932. Carbohydrate and nitrogen metabolism in the celery plant as related to premature seeding. Cornell Univ. Agr . Expt. Sta. Memoir 140.

12. Sadik, S. and J. L. Ozbun. 1967. Histochemical changes in the shoot tip of cauliflower during floral induction. Canadian. J. Bot. 45(7) : 955-959.

13. Sadik, S. and J. L. Ozbun. 1968. The association of carbohydrate changes in the shoot tip of cauliflower with flowering. Plant Physiol. 43 : 1696-1698.

14. Sheen. T. F. and S. C. Chuang. 1979. Effect of low temperature treatment on flower development in Peiping kohlrabi. Jou. of Agr. Res. of China 28(2) : 67-77.

15. Shinohara, S. 1950. Studies on the bolting of Japanese radish. Commemoration Issue of 50th Anniversary of Shizuoka Agr. Exp. Sta. 183-221. (In Japanese with English summary).

16. Shinohara, S. 1959. Genecological studies on the phasic development of flowering centering on the cruciferous crops, especially on the role of vernalizatoin on ripening seeds. Shizuoka prefecture agri. Exp. Sta. Japan. Technical Bulletin 6 : 1-166.

17. Sugiyama, N. 1942. Varietal difference of bolting behavior of radish and Brassica. Agri. and Hort. 17 (1) : 1453-1455. (In Japanese)

18. Suzuki, Y. 1972. Studies on vernalization in some cole and root vegetable, especially on the transition of low temperature sensitivity and the metabolic change during vernalization. Fac. Agr. Tokyo Uni. of Eduction 18 : 27-92 (In Japanese with English summary).

19. Wang, P. J. 1969a. Changes in the anatomical structure of the shoot apex of To-pe-tsai (*Brassica chinensis* L.) during transition form the vegetative to the reproduciive state and the determination of the bolting. J. Jap. Soc. Hort. Sci. 38 : 52-9.

20. Yamato K. 1932. Effect of low temperature on flower promotion. Agri. and Hort. Vol. 7 (1) : 861-868. (In Japanese).

21. Yamasaki, K. 1962. On the flower formation in some vegetable crops, with special reference to the transitional susceptibility of the growing towards the environmental factors responsible for the flower differentiation. Bull. Hort. Res. Sta. Japan. ser. B. No. 1 : 88-141. (In Japanese with English summary)

大梅花蘿蔔低温處理與開花之關係[1]

沈 再 發[2]

摘 要

本試驗以種子春化型之蘿蔔爲材料，一方面研究亞熱帶地區選種育種上對於較晚抽性母株之開花促進方法，一方面研究其低溫處理時，莖頂（Shoot apex）的發育過程與組織內氮和碳水化物之代謝情形。

經試驗結果大梅花蘿蔔成株，於選拔後剪去葉身，以根行 9±1°C 之有光低溫處理三週，可達完全抽苔開花。

以成株行低溫處理二週時，其莖頂之外鞘層（Tunica layer）由營養生長之 5 層變爲 6 層，低溫處理三週時又轉變爲 3 層，同時莖頂之細胞分裂旺盛，內體層（Corpus layer）之細胞形狀由平坦狀轉變爲豐滿之豎立狀。經四週低溫處理開始形成花原基。在低溫處理期間糖類增加，其含量達最高時，莖頂之細胞分裂旺盛，外鞘層轉爲 5 — 6 層。當外鞘層減爲 3 層和花原基形成時，糖類隨而下降。此種糖類之消長狀況與綠植物春化型之成株低溫處理之變化大致相同。

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1. 臺灣省農業試驗所 研究報告 第 1015 號。

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利用種子生產馬鈴薯之研究[1]

塊莖性狀與產量[2]

曹 幸 之

摘要：馬鈴薯的自交，自然授粉與雜交種子，在網室中，經一個月的育苗后，移植於農業試驗所試驗田，再經三個月後採收並調查幼苗移植後在田間的成活率，單株產量及達 30 g 的塊莖數與總重，薯色與薯形，芽眼的深淺。以種子來生產馬鈴薯，其產量比以種薯生產者爲低，但薯色、薯形與芽眼深淺等性狀的分離差異不顯著。貧瘠粘重的土壤也造成低產。

利用種子來生產馬鈴薯的目的有二：（1）節省生產種薯用地的面積並降低生產成本，（2）種子不帶病菌及毒素（本省常見之 PVX, PVY, PLRV 等），可免除種薯帶病之威脅及須有冷藏設施之增加成本等問題。在印度、紐西蘭等國[(3)]曾根據試驗結果，認爲可以利用種子來實用生產馬鈴薯，在我國大陸自 1972 年至 1979 年推廣利用此栽培方式，其面積已達二萬餘公頃。本所於民國68年秋曾調查九百餘種馬鈴薯在自然栽培環境下的開花結果情形(曹幸之，未發表)，及長日處理與以番茄爲砧木嫁接方法對於促進開花的效果[(1)]，先後均獲結果，故本試驗擬就所收集之種子續做下列各項之調查研究：

1. 種子直播或育苗移植，在田間的成活率與植株之生長情形。
2. 塊莖產量
3. 薯色薯形的一致性。

材料與方法

一、試驗地點：農業試驗所園藝系。

二、材料：本所收集的 28 個品系（見附表）的自交，自然授粉 (op) 種子及 5 個栽培品種的自交與雜交種子爲材料。

三、種子處理：所有種子先以 100 ppm 激勃素液，在 23°C 下，遮光浸種兩天。

四、種植方法：分直播與育苗移植兩種。

（一）直播：於 69 年 10 月 13 日至 15 日，將 5 個品系— No. 26, No. 28, No. 138, No. 475 與 No. 481 的自然授粉種子及五峰品種的自交種子以逢機排列順序播種，畦高約 10~15 cm，播種深度約 1.5 cm，行株距爲 85 cm×30 cm，每穴約播種子 5 粒（種子小，浸 GA 液後未經乾燥），播種後即行畦溝灌水。

（二）育苗移植：同年 10 月 9 日至 15 日，在網室內，利用水稻育苗盤(60 cm×30 cm×3 cm)裝盛混以稻穀或稻桿的田土，劃行播種，種子上下均爲細砂並不直接接觸田土，並分兩次移植，先於

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1. 臺灣省農業試驗所 研究報告 第 1016 號・本研究承臺大洪立教授斧正，謹誌謝忱。

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11月12日至16日，苗高達8～12 cm時，帶土逢機移植於A田，每穴1～3株不等，行距85 cm，，穴距 25～30 cm，，另有 10 月 28、29 兩日種植同品系（種）之十個種象爲對照。第二次於11月28至12月4日以同法移植於 B 田，另以9個品種（系）—No. 26, No. 28, No. 125, No. 138, No. 180, No. 254, No. 354, No. 475 與農林一號，各種5薯球爲對照。

A 田前作物綠豆，於九月末將綠豆作綠肥翻入土中以增有機質，經整地並開溝，以便畦溝灌水，B 田無綠肥，爲一期水稻收刈後即行翻犂，掘土爲穴，並未碎土做畦，移植後先人工澆水數日，後培土開溝成畦，才行畦溝灌水。

各品系之不同種子族羣由數株至千餘株不等，苗數少者移植於同一行，直到種完爲止，苗數多者則逢機移植於不同行中，株數越多，其種植行數也越多。移植後兩週、四週，均各行施肥與培土一次，第六週再培土一次。人工除草與噴施殺草劑兼用。

五、採收調查：A 田於 70 年2月 21 日起採收，時逢天雨直到3月3日始收完畢， B 田於3月4日至6日採收，並調查單株總薯重、薯數、薯形、薯色與芽眼的深淺。由於移植時各穴幼苗數不等，爲方便計，以採收時的株數與移植穴數比率來表示移植後至採收時的存活率。

結　　果

一、直播：六種不同的馬鈴薯種子，直播田間兩週後，No. 28（op）尚未出苗，其他品系發芽率亦低，No. 475（op）的發芽率最高，但也不到 20 %，且發芽先後參差不齊，並因後來雜草叢生，生育甚差而於 11 月 10 日廢耕。

二、移植：各族羣之種子在網室內育苗，一般發芽整齊且生長迅速，播種 10 日後，發芽率即達80%，但各族羣幼苗間的生長速率有快慢差異，故苗高不等，長至 6 cm 以上時即培土 1～2 cm，第一次移植時幼苗已有5片以上之本葉，苗高達 8～12 cm。育苗期間僅最初因較潮濕，有些葉片出現暗褐色斑點，噴施鋅錳乃浦即遏止外，未見其他病害發生，但本田生育期間（約三個月）仍有蚜蟲爲害。受害植株漸有捲葉、嵌紋等毒素病徵，在最初一個半月期中曾拔除燒毀之，以免漫延。在 B 田生長的植株有捲葉病狀者較少，拔除者亦較少，但一般生育狀況均較 A 田者爲差。各族羣之後代，罹病率不同，但本試驗未做比較。

移植成活率在 A 田的 50 個種子族羣平均爲 63.6 %（表1），此因移植後遇大雨幼苗因子苗立枯病（damping off）死亡甚多，在 B 田移植的 61 種族羣的幼苗，平均成活率62.2 %。

三、產量調查：產量最高的品系爲 No. 354，平均每株產量爲 433.6 g，在 A 田的50種族羣平均產量爲每株 208.8 g（表1），在 B 田的植株產量較低，61 個族羣的平均爲 79.7 g／株，其中幾乎半數族羣的產量平均僅 50 g／株。以種薯生產者爲對照，在 A 田 28 個品系生長3個月，其平均產量爲 522.2 g／株（每株是一個種薯種的），在 B 田同期生長的9個品系，其平均產量爲 292.8 g／株，均較在 A 田生長者爲低，顯示 B 田的土質貧瘠，不適馬鈴薯生長。由種薯生長之塊莖產量均較以種子生產者爲高而各品系不論以種薯或種子種植，在兩塊不同田地上的表現並不一致。有些品系在 A 田產量高但不一定在 B 田也有高產量。馬鈴薯種子可用來直接生產食用塊莖，也可先生產種薯而後切塊繁植，這種薯塊以30 g 以上爲宜，因此只計算每個達到 30 g 的塊莖，則各種子族羣的單株薯重與薯數的分布情形如表2，在 A 田平均每株有 2.3 個塊莖，共重 138.6 g，在 B 田則僅 0.5 個重 25.5 g。

各品系（種）的塊莖均爲圓或橢圓形，淺芽眼、薯色則多爲黃白色（附表），其種子後代就

表 1. 由馬鈴薯種子育成之苗定植於田間的成活率 (%) 與單株產量 (g) [a]

Table 1. TPS[b] progeny distribution according to survival rate (%) and yield per plant (g.)

存活率 Survival rate (%)	種子族羣數 Number of progenies A 田 Field A	種子族羣數 Number of progenies B 田 Field B	產量 Yield per plant (g/pl)	種子族羣數 Number of progenies A 田 Field A	種子族羣數 Number of progenies B 田 Field B
91—100	2	6	401—450	1	0
81—90	2	6	351—400	4	1
71—80	9	6	301—350	0	1
61—70	17	11	251—300	4	0
51—60	9	12	201—250	10	0
41—50	5	9	151—200	12	4
31—40	1	7	101—150	7	9
21—30	2	3	51—100	10	19
11—20	1	1	<50	2	27
1—10	2	0			
最高 (MX.)	100	100	最高 (MX)	433.6	388.5
最低 (MN.)	8.7	20	最低 (MN)	32	20
平均 ($\bar{m}$)	63.6	62.2	平均 ($\bar{m}$)	208.8	79.7
			種薯之平均產量 tuber clone avg	522.2[c]	292.8[d]

a. 定植日期:69 年 11 月 12 日至 16 日 (A 田) 與同年 11 月 28 日至 12 月 4 日 (B 田).
Transplanting date: November 12 to 16 (field A) and Nov. 28 to Dec. 4, 1980 (field B).
採收日期:70 年 2 月 21 日至 3 月 3 日 (A 田) 與3月4日至6日 (B 田).
Harvesting date: February 21 to March 3 (field A) and Mar. 3 to 6, 1981 (field B).

b. TPS: true potato seed.

c. 每品系 10 個種薯，28 個品系的平均產量。
Average yield of 28 tuber clones planted by 10 tubers each.

d. 每品系 5 個種薯，9 個品系種的平均產量。
Average yield of 9 tuber clones planted by 5 tubers each.

芽眼深淺，薯形與薯色等性狀的分離現象如表 3 所示，一般原爲黃白色薯的品系 (種)，其種子後代之塊莖仍以黃白色爲主，只有一個品系 No. 125 有 28% 的種子後代產生全黃或全白以外顏色的塊莖，而原是紅色薯的品系 (種)，其種子後代分離出深淺不同的紅色與黃白色。品系 No. 123 有 25 %的種子後代產生的塊莖具有明顯的深芽眼，其他品系 (種) 的種子後代仍產生淺芽眼的塊莖；薯形的分離很少，以圓或橢圓形爲主，僅少數長形薯。

討　論

一、種子的利用與種植：傳統上馬鈴薯用種薯繁殖，而細小的種子(約 0.5 mg)僅育種家用於育種多爲第一年在網室或溫室內選拔具有優良性狀的種生苗(seedling)後，再逐年利用無性繁殖據估計，在亞熱帶地區生產健康種薯的費用加上貯藏與運送的設施等費用，約佔 40～70 % 的生產成本[2]。而近年來亞熱帶地區已開始嘗試利用種子來生產馬鈴薯，因爲一般毒素除 PSTV (potato spindle

表 2. 由種子生產馬鈴薯之單株薯重與薯數（以 ≧30g 之塊莖計）

Table 2. TPS[a] progeny distribution according to yield and number of tubers (≧30g) per plant

產量 Yield per plant (g.)	種子族羣數 Number of progenies A田 field A	B田 field B	薯數 Number of tubers ≧30g	種子族羣數 Number of progenies A田 field A	B田 field B
351—400	1	0	5.1—6	2	1
301—350	0	0	4.1—5	3	1
251—300	4	1	3.1—4	0	1
201—250	1	0	2.1—3	21	0
151—200	11	2	1.1—2	10	4
101—150	12	1	≦1	11	34
51—100	7	3	0	3	20
≦50	11	34			
0	3	20			
最高 (MX)	352.3	271	最高 (MX)	5.5	5.8
最低 (MN)	0	0	最低 (MN)	0	0
平均 ($\overline{m}$)	138.6	25.5	平均 ($\overline{m}$)	2.3	0.5

a. TPS : true potato seed

表 3. 由種子育成之馬鈴薯後裔就芽眼深淺，薯形與薯色的分離種子族羣數

Table 3. Segregating characters of bulked TPS progeny for each line.

分離率 Segregation %	深芽眼 deep eye	長形薯 long tuber	黃白色以外的薯 different colored tubers produced by white (yellow) tuber
21—25	1	0	1
16—20	1	0	0
11—15	2	0	1
6—10	2	7	0
≦5	8	10	6
0	18	15	13
Total	32	32	21

tuber virus), APLV (andean potato latent virus) 外，都不經種子傳遞[3,4]。用種子生產種薯時可利用集團選種 (Mass selection) 或配合營養系選拔 (clonal selection)，再大量生產馬鈴薯供食，但這種繁殖栽培僅適於無蚜蟲感染的隔離地區或種生苗對毒素有耐病性者亦可栽培，否則低產無虞。

利用種子可分直播與育苗移植兩法，直播一般僅用於試驗，而且發芽率低而影響產量，不適經濟栽培之目的。種子又具有休眠性，休眠程度依品種不同，且發芽需時甚久，適宜發芽的溫度範圍很窄

，適溫爲 20°C，當溫度高過 25°C 則抑制發芽[5]。本試驗中，所有種子先已放置4～6個月，又經 GA 處理。雖未經發芽試驗，但播種於網室時一週內即有陸續發芽情形，顯示各品系種子均有很高發芽潛力，但同時直播於本田的種子發芽較慢，發芽率很低且參差不齊，當爲環境因素所致，因種子幼苗在生育初期極不耐任何不良的環境，如乾旱、病蟲害等。且當時胚根已露出 2 mm，雖然播種時，深度以不超過 1.5 cm 爲原則，却因土質粘重，畦溝灌水後加上田間高溫（當時平均氣溫爲 31.5°C 日／22.2°c 夜），造成的土壤結塊（crust）與土壤高溫均不利於幼苗出土生長。播種於網室的種子散佈均勻，上下均爲細砂，早晚以噴霧式澆水，減少土壤結塊之現象，且網室因有遮蔭，溫度也較田間爲低（出土後平均氣溫 29.8°C 日／20.2°C 夜），幼苗生長良好。因之直播宜在適當的溫度下，土壤也要疏鬆且富含有機質，尙需保護幼苗，儘量少受環境與土壤的不良影響，另外還可應用歐美盛行於芹菜等小種子蔬菜播種的 Fluid drilling 法，其法是將催芽後的種子均勻混在膠液（gel）內再播施於田間。

由於直播方式使植株在田間生長的時間較久，就本省現行耕作制度與病蟲害猖獗的生長環境下，祇宜先作小面積或有保護設施下栽培（如網室），先培育生長良好的幼苗再移植，縮短植株在田間的時期。另育苗時之苗床應逐步補充土並及時疏苗。利用種子生產馬鈴薯在本省爲創擧，由於對種子之發芽情形不甚明瞭，故播種時太密，以致需大量疏苗，今後再做重覆試驗時當可依播種面積計算種子需量（1g 有1,600～1,850粒）；移植適期爲苗高 6～12 cm[2]，本葉約5片時，本試驗中幼苗出土一個月後，Berolina 與五峰種兩品種的雜交種子所生育之幼苗中開始有匍匐莖與小的塊莖，至第二次移植時（11 月 28 日～12 月4日），幼苗已生長一個半月，品系 No. 125 的種生苗也有多株結有塊莖，其直徑達 1 cm 以上，有一單株已有5個小塊莖，顯示各種生苗結塊莖之早晚不同，可做爲育種上選拔的參考。移植時，若幼苗已結塊莖，會降低產量[4]或許也是 B 田產量較低的原因之一，但本試驗未做此比較。移植時之密度宜每穴3～5株，幼苗在本田成活期中先有大雨爲害於 A 田，後受毒素感染，因此須先選用較有抗病性的品系爲親本。直播栽培時可多播種子，移植栽培應密植，以增加耐病植株的比率才不至造成大量缺株而減產。

二、種子的評估：用種子生產馬鈴薯不但植株生長期較久，且每株因遺傳組合不同，以致成熟期、產量與質量均不一致，因此適宜的親本，必須秉具相當的耐病性，與能大量生產雜交組合種子的特性，還要後裔分離小，能適應產地之環境。生產種子可由下列二方法：

（一）雜交組合（controlled cross）：可以兩個優良的四倍體品種爲親本，必須其所生產的種子後裔也相當一致。另外可以用雙單元體（dihaploid), Peloquin 和 Mok（1975）已發現在一些二倍體馬鈴薯中有一種 FDR(First division restitution) 變異體（mutant），不行正常減數分裂，生成的 2N 配子可以保存原二倍體親本80%的基因組合，若親本爲相當異質遺傳組合（heterozygous），用爲父本，生成很一致而具高度異接合性（heterozygosity）的花粉，與優良四倍體品種雜交，所得種子後裔產量很高而且相當一致。

（二）自然授粉（open pollination）：此法比較省工，但所用親本仍須結果率高，果大種子多，並且需有相當的異結合性（heterozygosity），以避免自交減產，因馬鈴薯係自交作物，大約 80% 的自然授粉種子仍爲自交種子。

本試驗中所用種子多爲自交種子（自然授粉種子仍多爲自交種子），雖然產量不如以種薯繁殖者高，品系內（within line)變異大，但其中品系 No. 354 的平均總產量還有 0.43 kg/株，30 g 塊莖的產量爲 0.35 kg/株，其最高單株產量爲 2.6 kg，另外品系 No. 123 雖有 $\frac{1}{4}$ 之種子後裔生產的塊莖芽眼較深，但單株產量有 0.39 kg，其中有一行平均爲 0.51 kg/株，顯示有些品系的種子可以

用來生產馬鈴薯，但五峰、農林等品種的自交種子後裔產量均低。採收時許多植株仍綠，表示其成熟期較晚，若再延後採收，當可再增加一些產量，又因種子育成之苗是一株一主莖，而薯塊種植可得數株主莖，其產量必有差異之現象。

今後除需另尋選適宜實生栽培的品系或品種，其實生苗單株能有 0.6 kg 以上的產量，則設田間成活率爲 80 %，栽培密度 5 萬株，則每公頃可有 24 公噸的產量（0.6×0.8 × 50,000）（目前依農業年報統計，每公頃產量平均 12.3 公噸）外，對於本試驗中產量中高以上，而種子容易生產的種子後裔（progeny）當再做進一步田間試驗並改善田間栽培管理技術。

參 考 文 獻

1. 曹幸之、張有明. 1980. 馬鈴薯種子繁殖栽培之硏究—開花與結實。中華農業硏究 29(4)：321-328
2. Accatino, P. 1979. A progress report on potato production from true seed at the International Potato Center. CIP publication, 2 pp.
3. Anony. 1980. Report of the planning conference on the production of potato from true seed, held at Manila, Philippines, September 13-15, 1979. CIP publication 172 pp.
4. Anony. 1980. True potato seed (TPS) Letter. Vol. 1, No. 1, 4 pp.
5. Anony. 1980. TPS Letter. Vol. 1, No. 2, 2 pp.

附表 28 個品系與 5 個品種馬鈴薯及其薯色

Appendix. Potato lines and varieties used and their tuber skin color

代號 Line No.	品系（種） Variety name	薯色 Tuber skin colov
26	ADH-69-1	Yellow
28	AGD-69-1	Yellow
37	CCM-69-1	Yellow
47	CCL-69-1	Yellowish white
49	AQC-69-1	Light red with red eye
54	Juanita X NWS-66-66(58)	Yellow
83	ACK-69-1	Yellow
123	63-77-WIS-BR	Yellow
125	AFX-69-1	Yellow
138	INDIA-844	Yellow
170	Juanita X NWS 66-66(52)	Light red with red eye
180	66-66/1	Yellow
245	AJE-69-1	light red with red eye
254	AEK-69-1	Yellow
294	NWS-66-166 X Atzimba(142)	Yellow
338	WIS-BR-63-23	Yellow
339	WIS-BR-63-65	Light red with red eye
354	WIS-BR-69-74	Red with dark red eye

續附表

代 號 Line No.	品 系 (種) Variety name	薯 色 Tuber skin colov
425	WIS-BR-69-170	Yellow
450	ABJ-69-1	Yellow with red eye
463	WIS-BR-65-10	Purple
475	AHN-69-1	Whitish Yellow
481	BPN-69-1	Yellow
664	CAK-69-1	Yellow
666	BQF-69-1	Dark red
717	CEZ-69-1	Light red
792	POOS-193	Light red
B	Berolina	Yellowish white
C	Cardinal	Red
N	農林	Yellow
O	Omega	Yellowish white
五	五峰	Yellowish white

Study on potato production by true seeds tuber characteristics and yield[1]

Shing-jy Tsao[2]

Summary

True potato seeds from various open-, self- and cross-pollinated progenies were evaluated by transplanting one-month old seedlings to two different field conditions at TARI, Taichung.

Crops were harvested in 3 months and the following data was recorded on plant basis for each progeny : total tuber weight, weight and number of tubers equal to and above 30g., survival rate (% of transplants survived till harvest time), tuber skin color, shape and depth of eye. The segregation for the latter three traits was not significant in general. The highest yield obtained was 0.43 kg/pl. in comparison to 1.08 kg/pl obtained from tuber clone.

The yield was markedly reduced for both tuber clone and seedling at heavy and less fertile soil.

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Studies on seed production techniques of water convolvulus (*Ipomoea aquatica* Forsk.)

II. Effect of planting dates on the seed production potentiality of different cultivars of water convolvulus grown under paddy and upland fields[1]

Tsung-dao Liou[2]

Abstract: Two cultivars of water convolvulus, cv. Pingtung Green Stem(pointed leaf)and cv. White Stem (broad leaf) were planted in paddy and upland fields jn early July, August, September and October of 1978. The days of flowering after planting (DFAP) of these two cultivars indicated shortened period when planted late. They showed similar horticultural characters and seed production potentialities. Cultura l conditions (paddy or upland) did not influence flowering time, but there was difference on flowering time of these two cultivars, White Stem flowered earlier than Pingtung Green Stem. Hundred seeds weight was significantly influenced by planting dates, but not by cultural conditions. On the contrary, ave. length of each node per tiller was significantly influenced by cultural conditions, but not by planting dates. Ave. length of tiller per hill, ave. no. of nodes per tiller, no. of flowers per hill, no. of capsules per hill, straw weight, seed yield and grain/straw ratio of water convolvulus were significantly influenced by the planting dates and cultural conditions. Water convolvulus planted in upland conditions showed that the plant vigor and seed production potentiality were better than in paddy fields. Straw weight in upland culture was 6,839 kg/ha, higher than in paddy culture of 3,185 kg/ha. Seed yield was also higher in upland culture of 1,221 kg/ha than in paddy culture of 795 kg/ha. Between different planting dates, straw weight showed highest on July planting of 6,781 kg/ha and lowest on October planting of 3,352 kg/ha. However, seed yield showed highest on August planting of 1,332 kg/ha, second on July planting of 1,284 kg/ha and lowest on October planting of 553 kg/ha. The data showed that both White Stem and Pingtung Green Stem water convolvulus are more favourable for planting on upland condition in Southern Taiwan. Suitable planting dates for water convolvulus seed production culture are during late July to early August. This information may be valuable to farmers who are interested in water convolvulus seed production.

Water convolvulus (*Ipomoea aquatica* Forsk.) is a semi-aquatic vegetable, tolerant

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to heat and flooding. [3,6,7,9] It contains lot of proteins, minerals and vitamins. It is popularly cultivated by the farmers and welcome by the housewives in Southeast Asian countries, and has become a very important summer leafy vegetable in Taiwan due to its high yields, less occurrence of pest and disease, rapid growth rate and easy cultivation under high temperature, high moisture in summer tropical monsoon season. [4,5,8,11,12,13,14,15]

Water convolvulus culture in Taiwan is mainly cultivated with direct seed method whereas cutting method is subsidiary. [7,9] In accordance with statistical data, acreage of water convolvulus increased gradually each year, the case in 1978 was 3,605 hectares. [2] Therefore, more water convolvulus seeds are required each year. Various seed production method and impure water convolvulus varieties in local production area of Taiwan showed low seed yield. [1] A series approach on improvement of water convolvulus seed production techniques has become very important. This paper continued on previous research [10] for searching optimum planting dates of different cultivars of water convolvulus grown in paddy and upland conditions in Southern Taiwan.

Material and Methods

Two popular cultivars of water convolvulus, cv. Pingtung Green Stem (pointed leaf) and and cv. White Stem(broad leaf)were used. Both two cultivars were planted in paddy and upland fields with cutting methods. All cuttings were planted at experimetal farm of Fengshan Tropical Horticultural Experiment Station on July 10, August 10, September 10 and October 10 of 1978, respectively. Source of all cuttings planted in each planting dates were cut from old plants of the same nursery bed that have been seeded on June 15 of 1978. Soil texture of the experimental farm belongs to loamy soil. Both paddy and upland seed production cultures were a randomized complete block design with 4 replications. Fertilizer rate on the experiment were 20 ton/ha of compost, 200 kg/ha of nitrogen, 100 kg/ha of P_2O_5 and 200 kg/ha of K_2O. All fertillizers were applied with broadcasting method during land preparation. On paddy field land preparation was the same as rice culture. 4 m$\times$1.4 m of bed was prepared in upland culture, however, nylon thread was used for labelling the position of the bed of the same size in paddy culture instead of making bed. Each plot contains three beds. Each bed planted 4 rows of 25 cm$\times$25 cm distance between row and within plant hills. Each hill was planted two cuttings with 15—20 cm length. Plot size were 16.8 m^2. Acreages of each planting date were 268.8 m^2 and added 89.6 m^2 of guard row. Both paddy and upland cultivation were planted on the same time. Plant vigor and important horticurtural characters, such as the days of flowering after planting (DFAP), no. of tillers per hill, ave. length of tillers per hill, ave. no. of nodes per hill, ave. length of each node per tiller, no. of flowers per hill, no. of capsules per hill, flower drop percentage, fruit set percentage, ave. no. of seeds per capsule, 100 seeds weight, straw weight, seed yield and grain/straw ratio were recorded during experiment period. All investigation data were processed by the methods of combined analysis of variance. [16] Crop was managed in accordance with general cultivation method of water convolvulus.

Results and Discussion

I. Effects of planting dates on the vegetative growth period of different cultivars of water convolvulus grown in paddy and upland fields

Table 1 shows the days of flowering after planting (DFAP) of these two cultivars became shorten when planted late. DFAP showed that July planting was the longest and October planting the shortest. On White Stem, it needs ca. 49 days DFAP when planted in July, while, Pingtung Green Stem, needs ca. 80 days. Both White Stem and Pingtung Green Stem flowered on the following day after being planted in October, because cuttings had had flower bud when planted. Cultural conditions (paddy or upland) did not influence flowering time of these two cultivars. Difference on flowering time of these two cultivars was observed, White Stem flowered earlier than Pingtung Green Stem. Changes of flowering time and flower behavior of these two cultivars showed that water convolvulus was sensitive to day length. It might be a short day crop. How the water convolvulus flowering time responds to day length still needs future research.

Table 1. Effects of planting dates on the days of flowering after planting (DFAP) of different cultivars of water convolvulus grown under paddy and upland fields

Treatment	White Stem		Pingtung Green Stem		Difference (days)
	Date of planting	DFAP	Date of planting	DFAP	
Paddy culture	10.VII	49.0	10.VII	79.8	30.8
	10.VIII	27.5	10.VIII	51.8	24.3
	10.IX	7.0	10.IX	22.3	15.3
	10.X	1.0	10.X	1.0	0
Average (1)		21.1		38.7	17.6
Upland culture	10.VII	43.5	10.VII	78.5	35.0
	10.VIII	28.5	10.VIII	48.3	19.8
	10.IX	9.5	10.IX	22.5	13.0
	10.X	1.0	10.X	1.0	0
Average (2)		20.6		37.6	17.0
Difference (1) − (2) (days)		0.5		1.1	

II. Effects of cultivars, planting dates and cultural conditions on horticultural characters and seed production potentiality of water convolvulus

1.Comparison of horticultural characters, fruit setting and seed production potential

of White Stem and Pingtung Green Stem water convolvulus

As table 2 shows, all the horticultural characters did not vary much between these two cultivars. Positive correlation between straw weight and seed yield of thes two cultivars was found in Figure 1. The correlation coefficient of white Stem shows r = 0.9830 and Pingtung Green Stem shows r = 0.9470. The data showed almost the same plant vigor and seed production potentiality between these two cultivas.

Table 2. Comparison of horticultural characters, fruit setting and seed yield of two cultivars of water convolvulus.

Cultivars	Ave. No. of tiller per hill	Ave. length of tiller per hill (cm)	Ave. No. of node per tiller	Ave. length of each node per tiller (cm)	No. of flower per hill	No. of capsule per hill	Flower dropping %
White stem	7.41 a[a]	84.33 a	22.46 a	3.79 a	246.2 a	187.3 a	23.92 a
Green stem	7.84 a	83.86 a	23.71 a	3.48 a	254.5 a	197.2 a	22.51 a

Cultivars	Fruit setting %	No. of seed per capsule	100 seeds weight (%)	Straw weight (kg/ha)	Seed weight/ 16.8m² (kg)	Seed yield (kg/ha)	Grain/ straw ratio
White stem	76.08 a	3.6656 a	3.9719 a	5206.5 a	1.6414 a	977.0 a	0.1877 a
Green stem	77.49 a	3.7031 a	3.9845 a	5447.5 a	1.7457 a	1039.1 a	0.1908 a

a. Mean in a column followed by different letters are significantly different at 5% level according to Duncan's multiple range test.

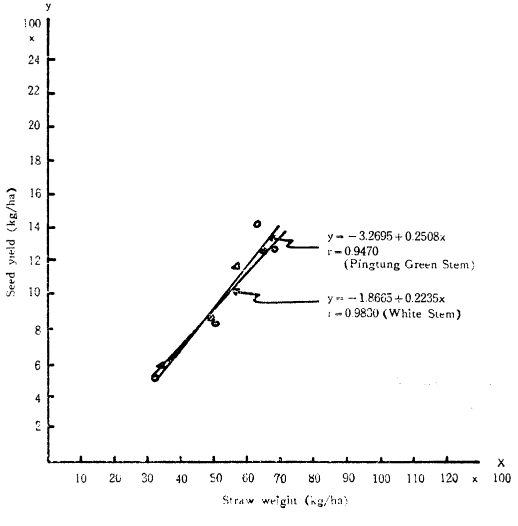

Fig. 1. Correlation between straw weight and seed yield of two cultivars of water convolvulus.

2. Effects of cultural conditions on horticultural characters, fruit setting and seed production potentiality of water convolvulus

Table 3 indicates that there are no significant difference between paddy and upland culture on some horticultural characters, such as no. of tillers per hill, flower drop percentage, fruit set percentage, no. of seeds per capsule and hundred seeds weight of

Table 3. Comparison of horticultural characters, fruit setting and seed yield of water convolvulus grown in paddy and upland fields.

Treatment	Ave. No. of tiller per hill	Ave. length of tiller per hill (cm)	Ave. No. of node per tiller	Ave. length of each node per tiller (cm)	No. of flower per hill	No. of capsule per hill	Flower dropping %
Paddy culture	7.81 a[a]	53.46 b	22.17 b	2.63 b	182.9 b	139.5 b	23.73 a
Upland culture	7.44 a	109.72 a	24.01 a	4.63 a	317.9 a	245.0 a	22.93 a

Treatment	Fruit setting %	No. of seed per capsule	100 seeds weight (g)	Straw weight (kg/ha)	Seed weight/ 16.8 m² (kg)	Seed yield (kg/ha)	Grain/ straw ratio
Paddy culture	76.27 a	3.6688 a	3.9582 a	3815.3 b	1.3351 b	794.7 b	0.2089 a
Upland culture	77.07 a	3.7000 a	3.9983 a	6838.7 a	2.0520 a	1221.4 a	0.1786 b

a. Mean in a column followed by different letters are sighifijcantly different at 5% level accordijng to Duncan's multiple range test.

water convolvulus. It showed significant difference between paddy and upland culture on ave. length of tillers per hill, ave no. of nodes per tiller, ave. length of each node per tiller, no. of flowers per hill, no. of capsules per hill and grain/straw ratio. Table 3 and

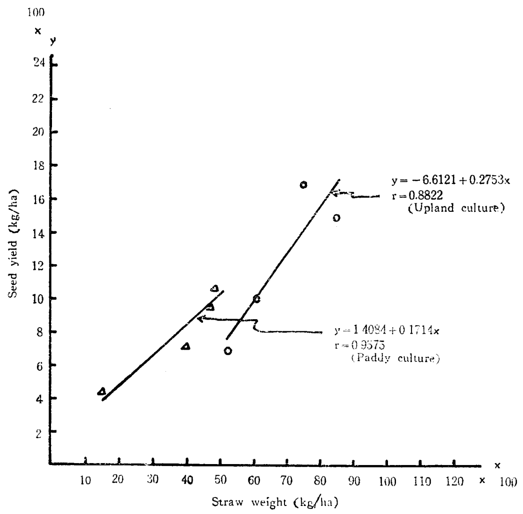

Fig. 2. Correlation between straw weight and seed yield of water convolvulus grown under paddy and upland field conditions.

Figure 2 show, in case of straw weight and seed yield, significant difference and positive correlation when it was grown under upland and paddy fields condition. The correlation coefficient was found to be r=0.8822 and r=0.9575, respectively. Straw weight in upland culture attained 6,839 kg/ha, higher than in paddy culture of 3,815 kg/ha. Seed yield also showed higher in upland culture of 1,221 kg/ha than in paddy culture of 795 kg/ha. It's clearly demonstrated, that water convolvulus seed production is more favourable for upland cultural conditions.

3. Effects of planting dates on horticultural characters, fruit setting and seed production potential of water convolvulus

Table 4. Effect of planting date on horticultural characters, fruit setting and seed yield of water convolvulus.

Date planted	Ave. No. of tiller per hill	Ave. length of tiller per hill (cm)	Ave. No. of node per tiller	Ave. length of each node per tiller (cm)	No. of flower per hill	No. of capsule per hill	Flower dropping %
10.VII.1978	7.50 a[a]	80.88 abc	25.78 a	3.14 a	233.4 bc	177.8 bc	23.81 a
10.VIII.1978	8.00 a	96.73 a	25.74 ab	3.69 a	323.4 a	258.7 a	20.01 a
10.IX.1978	7.25 a	95.19 ab	23.40 abc	4.09 a	264.6 ab	199.8 b	24.49 a
10.X.1978	7.75 a	63.57 c	17.43 d	3.60 a	180.1 c	132.8 c	26.26 a

Date planted	Fruit setting %	No. of seed per capsule	100 seeds weight (g)	Straw weight (kg/ha)	Seed weight/ 16.8m² (kg)	Seed yield (kg/ha)	Grain/ straw ratio
10.VII.1978	76.19 a	3.7375 a	3.9740 ab	6781.3 a	2.1571 ab	1284.0 ab	0.1893 ab
10.VIII.1978	79.99 a	3.6875 a	4.0909 a	6120.5 ab	2.2375 a	1331.9 a	0.2176 a
10.IX.1978	75.51 a	3.6875 a	3.9814 ab	5054.7 c	1.4506 c	863.5 c	0.1708 b
10.X.1978	73.74 a	3.6250 a	3.8666 b	3351.6 d	0.9290 d	553.0 d	0.1650 b

a. Mean in a column followed by different letters are singificantly different at 5% level according to Duncan's multiple range test.

Table 4 shows that there is no significant difference of planting dates on horticultural characters, no. of tillers per hill, ave. length of each node per tiller, flower drop percentage, fruit set percentage, no. of seed per capsule of water convolvulus. Horticultural characters, including ave. length of tiller per hill, ave. no. of nodes per tiller, no. of flowers per hill, no. of capsules per hill, hundred seeds weight, straw weight, seed yield and grain/straw ratio, showed significant differences due to planting dates. It seems that July and August planting are better ones and October planting worse. Straw weight was highest on July planting with 6,781 kg/ha and lowest on October planting with 3,352 kg/ha. Seed yield showed highest on August planting with 1,332 kg/ha, second on July planting with 1,284 kg/ha and lowest on October planting with 553 kg/ha. Since their is no significant differences between the seed yield of July planting and August

planting, we are not able to conclude whether August planting has the best straw yield for maximum seed production. The data showed that suitable planting time for water convolvulus seed production culture is during late July to early August in Southern Taiwan.

III. Vegetative growth stage factor regulating seed production potentiality of water convolvulus

Water convolvulus is a very important summer leafy vegetable in Taiwan due to its tolerance to heat, wet, boost growth rate and easy cultivation. It is also one of the higer plants which need optimum vegetative and reproductive growth for accelerating best growth and highest seed production potentiality. It flowers continuously from September to April of the following year. Seed production culture is concentrated in summer season as plants have enough time for vegetative growth for seed development after flowering. In order to find optimum planting dates for seed production, Pingtung Green Stem and White Stem were planted on July, August, September and October respectively on paddy and upland field conditions in this experiment. Figure 3 demonstrates that flowering time of water convolvulus has no apparent difference when grown under paddy and upland field conditions. But there appeared some differences within the two cultivars, White Stem flowered earlier than Pingtung Green Stem. Also revealed by this result is that different treatment of the same cultivar flowered at the same date regardless the

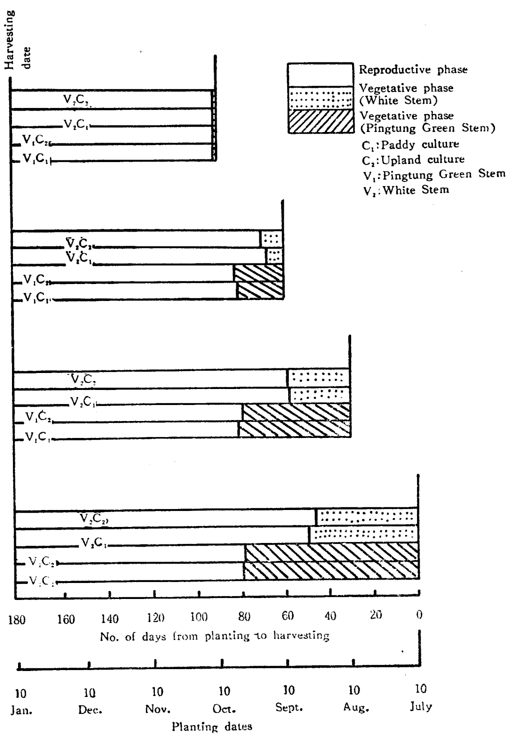

Fig. 3. Effects of planting dates on vegetative growth and reproductive growth of two cultivars of water convolvulus grown under paddy and upland fields.

planting date. It suggested that the flowering mechanism is probably controlled by photoperiod and different cultivar has different critical day length for flowering induction. However, the actual critical day length for these two cultivars is not determined by the data of this experiment. The flower inflorescene of water convolvulus is an auxillary cyeme with 3—7 flowers on each inflorescene. Flowering sequence of an inflorescence begins at lower node and continues to upper node.[10] Maturing stage of capsule on the plant does not take place at the same time due to continued flowering on elongated stem. Farmers cut whole plants when the capsules are 4/5 mature on the plants from December to early January each year. All plants were harvested on January 8th in this experiment. Seed yield of water convolvulus shows in Figure 4 has a positive correlation with straw weight and its r=0.8839. It indicates that higher straw weight will produce higher seed yield. Straw weight and seed yield obtained among each planting dates has been described previously. Biological yield of straw weight and seed yield varied between planting dates and cultural conditions as Figure 5 shows. Straw weight increased when planting date was postponed. It has no apparent difference between the two cultivars, but difference between cultural conditions. Upland culture attained higher straw weight than in paddy field. Seed yield is the highest on August planting. The above data shows that seed production potentiality of water convolvulus is actually regulated by the vegetative growth. Pingtung Green Stem needs more than 50 days vegetative growth and White Stem needs more than 30 days vegetative growth for acceleration of seed development. It also shown that the optimum duration for water convolvulus seed production culture in Southertn Taiwan is from late July to early August.

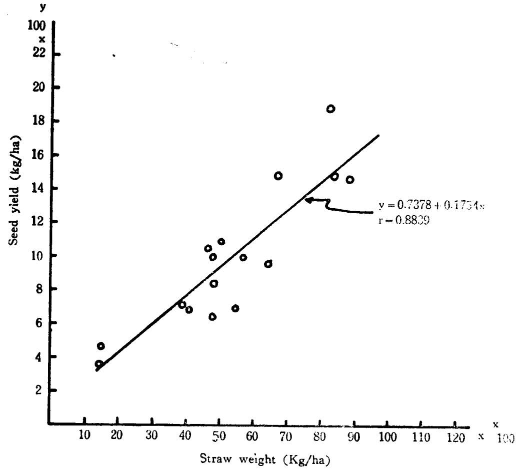

Fig. 4. Correlation between straw weight and seed yield of water convolvulus.

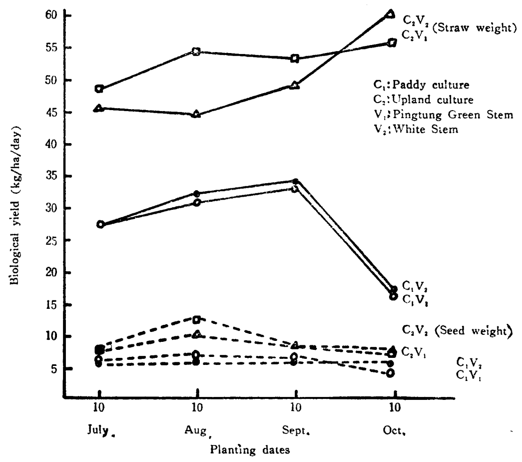

Fig. 5. Effects of planting dates on biological yield of water convolvulus grown under paddy and upland field conditions.

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Literature Cited

1. Chen, P. C. and I. L. Chen . 1970. A study on varietal purification of water spinach of Taiwan. 14pp. Reprinted from Report No. 24. Hsinchu District Agricultural Improvement Station, Hsinchu. (In Chinese).

2. Dept. of Agriculture & Forestry, Provincial Government of Taiwan. 1979. Taiwan Agriculture Year-book. p. 209 (In Chinese) .

3. Harry, H. E. and B. W. C. Ho. 1969 *Ipomoea aquatica* as a vegetable crop in Hong Kong. Econ. Botany 23 (1) : 32-36.

4. Huan, P. C. and S. L. Yuo. 1975. Essential of Nutritions. 273pp. Corporation Book Co., Taipei . (In Chinese).

5. Li, P. N. 1960. Studies on price inflation of summer vegetables in Taiwan. Quarterly bank of Taiwan 21 (2) : 1-26. (In Chinese).

6. Li, Y. H. 1966. Water convolvulus. Agriculture Guide. Book VIII Horticultural crops. Chapter 2 Vegetables p. 309-313. Dept. of Agriculture and Forestry, Provincial Government of Taiwan. (In Chinese).

7. Liou, T. D. 1977. Lowland cultivation of water convolvulus. Harvest Farm Magazine 27 (14) : 36. (In Chinese).

8. Liou, T. D. 1977. Studies on the response of nitrogen application to the growth and protein content of five tropical leafy vegetables. Jour. Chinese Soc. Hort. Sci. 23 (3) : 114-128. (In Chinese with English summary).

9. Liou, T. D. 1980. Water convolvulus. Vegetables Growing, Revised 3rd Edition, Harvest Farm Magazine, Taipei . (In Chinese).

10. Liou, T. D. 1980. Studies on seed production techniques of water convolvulus (*Ipomoea aquatica* Forsk.). I. Flowering habit and seed production potential of different varieties of water convolvulus grown under lowland and upland fields. Jour. Agric. Res. China 29 (4) : 251-258. (In Chinese with English summary).

11. Martin, F. W. and R. M. Ruberte. 1975. Edible leaves of the tropics. Mayaguez Institute of Tropical Agriculture, Mayaguez, Puerto Rico. 235pp.

12. Martin, F. W. and R. M. Ruberte. 1978. Survival and subsistence in the tropics. Antillian College Press. Mayaguez, Puerto Rico. 243pp.

13. Ortaliza, I. C., I. F. Del. Resarie, M. M. Caedo and A. P. Alcaraz. 1971. The availability of caro-tene in some Philippine vegetables. Philippine Jour. of Sci. 98 (2) : 123-131.

14. Schmidt, D. R. 1971. Comparative yields and composition of eight tropical leafy vegetable grown at two fertility levels. Agronomy Journal 63 (4) : 546-550.

15. Schmidt, D. R., H. A. MacDonald and F. E. Brockman. 1971. Oxalate and nitrate contents of four tropical leafy vegetables grown at two soil fertility levels. Agronomy Journal 63 (4) : 559 -561.

16. Sheen, M. L. 1980. Combined Analysis of Variance. 13pp. Dept. of Agronomy, NTU. (In Chinese).

蕹種子生產改進技術之研究

Ⅱ. 種植時期與栽培方式對不同品種蕹菜種子生產力之影響[1]

劉 政 道[2]

摘 要

屏東青骨尖葉蕹菜與白骨大葉蕹菜分別於 7 、 8 、 9 及 10 月種植於水田與旱田不同之栽培生育環境中，這兩品種蕹菜除開花時間隨種植時期之延緩而縮短到達開花所需之日數外，其餘各項園藝性狀與種子生產潛力幾乎相似， 7 月份種植者到達開花所需之日數，白骨蕹菜約爲 49 天，青骨蕹菜約爲 80 天，而 10 月份種植者因爲插植時插穗已帶有花蕾，於種植後翌日即開花，栽培環境對兩品種蕹菜之開花時間幾乎沒有影響，但品種間則有差異，白骨蕹菜比青骨蕹菜較早開花。蕹菜之每欉分蘗數、落花率、結實率、蒴果種子數等受種植時期與栽培環境之影響不顯著，種子百粒重受栽培環境之影響不顯著而受種植時期之影響顯著，平均分蘗節間長度受種植時期之影響不顯著而受栽培環境之影響顯著，蕹菜之每欉分蘗長度、平均分蘗節數、每欉花數、每欉蒴果數、藁重、種子產量與種子/藁比等均顯著的受種植時期與栽培環境影響，旱田栽培之蕹菜生育與種子產量均比水田栽培者佳，旱田栽培之藁重每公頃高達 6,839 kg，幾乎爲水田栽培 3,815 kg 之兩倍。種子產量亦以旱田栽培之每公頃 1,221 kg 比水栽培之 795 kg 爲多。各種植時期中以 7 月份種植之藁重最多，每公頃高達 6,781 kg， 10 月份種植者最低，每公頃僅 3,352 kg 而已。種子產量以 8 月份種植之每公頃 1,332 kg 最多， 7 月份種植之 1,284 kg 次之， 10 月份種植之 553 kg 最少。由此試驗結果顯示，在臺灣南部地區蕹菜採種栽培無論青骨蕹菜或白骨蕹菜均以採用旱田栽培爲宜，其最適當之種植時期應爲 7 月下旬至 8 月上旬，可爲農民蕹菜採種栽培之依據與學術研究之參考。

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1. 臺灣省農業試驗所 研究報告 第 1017 號。本文承蒙亞洲蔬菜研究中心鄒博士篪生、國立臺灣大學農藝系沈副敎授明來、沈分所長再發斧正，林主任昭雄賜閱，趙文慶先生協助，特此深致謝忱。

2. 本所鳳山熱帶園藝試驗分所助理研究員。臺灣省 鳳山市。

中華農業研究 (Jour. agric. Res. China) 30(4)：395～404 (1981)

甘藍與結球白菜貯藏試驗[1]

林學正　王為一　江慧鈴[2]　劉富文[3]

摘要「初秋」甘藍與「煙台」結球白菜各以厚 0.03 m/m 之 PE 袋包裝，進行長期冷藏試驗。發現 PE 袋包裝可以減輕二者葉片黃化、離層形成、莖部纖維化及苞葉軟鬆等品質劣變現象；袋內添加乙烯吸收劑，除更可減輕上述品質劣變外，能有效抑制甘藍黑心 (Tip burn) 生理病的發生，但不能抑制結球白菜的黑心病。後者發現與二氧化碳濃度過高 (＞5％) 有關。

甘藍以 PE 袋包裝並加乙烯吸收劑者，不論預冷與否，經 0°C 貯藏5個月後，其可售率仍達 60 ％，且品質良好，而以 PE 袋打洞包裝者，經貯藏3個月後，其可售率雖亦達 60 ％，但品質已經變劣，僅達可接受程度。結球白菜以 PE 袋密封包裝經 0°C 貯藏2個月後，發生嚴重的黑心與黑點病 (Black leaf speck)，並因袋內氧濃度過低與二氧化碳濃度過高致全部腐損。

封袋後經20天，袋內氣體即達平衡狀態，而後甚少變化。甘藍袋內大氣氧含量維持在1～12％之間，二氧化碳在 2.5～10 ％之間。而結球白菜袋內大氣氧則降到1％以下，二氧化碳升到 10 ％左右，顯然不適合 PE 袋包裝貯藏。利用人工控制大氣貯藏「成功」結球白菜，發現氧與二氧化碳各為 2.5 ％的組合有較長的貯運壽命。

本省夏季蔬菜缺乏，而冬季生產過剩，如何延長冬季蔬菜供應期，以舒解夏季蔬菜不足，為一重要課題。目前馬鈴薯、胡蘿蔔及洋葱可加以長期冷藏，供做夏季蔬菜[(4)]。但上述並非消費者經常食用之葉菜類，無法滿足大衆需要。

甘藍及結球白菜皆屬於冬季生產味美價廉之葉菜類，且較其他葉菜類有較長的貯藏壽命[(22)]。在我國北方及其他冬季覆雪國家，常以地窖或機械進行長期冷藏，以供應嚴冬及初春的需要。本省因貯藏技術與設備不够理想，此二類蔬菜經長期貯藏後，腐損率甚高，業者不敢貿然投資，僅止於短期貯運而已[(4)]。

目前，夏季對此二類蔬菜之需求，皆靠高冷地種植供應，但因其面積有限、水土保持不易及颱風造成交通中斷等不利因素，使栽培成本提高。此外，易造成土壤流失，水源污染等不良後果。因此，進行冬產蔬菜保鮮方法之研究，實有必要。

可透氣性塑膠膜用於蔬菜包裝已十分普遍，不但清潔美觀，且可造成有如人工控制大氣貯藏 (Controlled atmospheric storage) 之有利環境，能防止失水，延遲老化、抑制病原菌滋長並減少腐損[(6,10,25,26,30,31,33)]。利用人工大氣貯藏甘藍在歐美等先進國家早已商業化應用，不但可長期貯藏達7－9個月之久，而且可保持較高的商品品質及營養價值[(8,13,14,15,17,18,20)]。本研究即利用 PE 之良好透氣性，進行甘藍及結球白菜包裝貯藏，並配合乙烯吸收劑之使用防止老化，探討其實用性；另以結球白菜行人工大氣貯藏，以期明瞭低 O_2 及高 CO_2 之影響，進而尋求最適當之貯藏大氣組合，供

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日後研究或貯運之參考。

試驗材料與方法

供包裝試驗之「初秋」甘藍及「煙台」結球白菜，於民國 70 年2月 20 日採自溪湖地區，種植於多季休閒之水田，初期田間管理良好，後期因價格低落，管理較粗放；採收時約9分熟。供人工大氣貯藏之「成功」種結球白菜，於同年4月 29 日採自溪湖地區之蔬菜田，田間管理良好，採收時亦爲9分熟。

供包裝試驗用之甘藍及結球白菜，於下午採收，同時剝去外葉2片，放入厚 0.03 m/m 之 PE 塑膠袋內 (90×150 cm)，每袋各放8及4個，而後放入農林廳推荐之 PE 塑膠蔬菜貯運籃 (70×45×36 cm) 內。處理分爲：1.加乙烯吸收劑並田間封袋。2.加乙烯吸收劑於隔夜預冷後封袋。3.隔夜預冷後封袋。4.塑膠袋打洞爲對照。乙烯吸收劑之配製，係依蔣氏方法[1]稍加修改而得。將含 6.4% KM_nO_4 及 1% Na_2CO_3 混合液 2.8 cc 直接噴灑在 3.5 gm 硅石上，產品約含 5.12 %之 KM_nO_4，其可吸收之乙烯量未經測定。每袋放乙烯吸收劑 80 gm，採收後於6小時內置於卓蘭果菜市場冷藏庫，冷藏庫溫度爲 0～2°C，濕度爲 85～90 % R. H.

供人工大氣貯藏試驗之成功種結球白菜於下午採收後，當日運至本所冷藏庫，經隔夜預冷後，翌日以塑膠繩封口通氣。處理分爲：1. O_2 2.5%—CO_2 2.5%，2. O_2 2.5%—CO_2 5%，3. O_2 5%—CO_2 5% 及 4.塑膠袋打洞包裝爲對照。人工大氣貯藏裝置是將4個結球白菜置於厚 0.05 m/m 之塑膠袋 (60×90 cm) 中，以內徑 0.5 cm 之 PE 軟管兩隻作爲大氣出入口。不同組成大氣是以省產之氮、氧和二氧化碳配製而成[2]。所配之大氣經日製島津牌 GC-4C PFT 型氣相分析儀校正後使用。人工大氣以 200 ml/min 之流量，經水中加濕後導入袋中。庫房貯藏溫度爲 4°±1°C，濕度爲 85～90%R. H.。包裝試驗每處理重覆6次，人工大氣貯藏試驗重複2次。供試材料於試驗完成後，移置室溫 2 天，行模擬運輸販賣過程，所得部分結果經變方分析後，依 Duncan 氏多變域測驗法進行比較。

試驗結果

甘藍經3個月貯藏，隔夜預冷後密封處理者，外表雖未腐爛，但內部大部分已發生黑心生理病，失去商品價值，因此整修後可售率僅達 26.4 %。塑膠袋打洞包裝處理者可售率約爲 60 %；加乙烯吸收劑處理，不論有無預冷，其可售率皆顯著高於對照組，達 80 %左右。預冷對貯藏無顯著效果。加乙烯吸收劑並田間封袋處理者繼續觀察至4個月後，仍較對照組3個月貯藏期之可售率爲高，5個月後，其可售率約 60 %，與對照組三個月貯藏相近 (表 1)。

甘藍包裝處理中，各樣品袋內氧與二氧化碳消長情形頗爲一致。一般而言，氧與二氧化碳在貯藏後 20 天，即可達穩定平衡狀態 (Steady state)，直到開袋爲止。但由於塑膠袋本身品質不一[3]，各袋內氧與二氧化碳濃度各有差異，且差異頗大(圖1)。隔夜預冷後封袋處理者，袋內氧濃度在 10～12.5 %之間，二氧化碳在 5～7 %之間；加乙烯吸收劑於隔夜預冷後封袋處理者，袋內氧濃度在 4～12 %之間，二氧化碳在 6.5～10.0 %之間；加乙烯吸收劑並田間封袋處理者，袋內氧濃度在 1～10 %之間，二氧化碳在 2.5～10.0 %之間。甘藍經 90 天貯藏開袋後，並無低氧或高二氧化碳的生理障害發生。

甘藍整修的損失大部份係因受傷後感染灰黴菌 (*Botrytis* sp) 所引起，此病原菌之繁殖並不嚴重，僅止於外部2～3輪葉片而已。乙烯吸收劑可以防止甘藍黑心病的發生。預冷後密封未加乙烯吸收劑處理者，在貯藏3個月後，即出現嚴重黑心現象，徵狀爲心葉處褐化乾腐，而加乙烯吸收劑處理者，經5個月貯藏未發生黑心現象，對照處理貯藏3個月後，有少部份發生。莖部的纖維化對照組最嚴重，不加乙烯吸收劑處理者次之，加乙烯吸收劑者經3—4個月貯藏，只有輕微纖維化現象。甘藍

表 1. 塑膠袋包裝貯藏對「初秋」甘藍修整率、可售率、品質與生理病害之影響

Table 1. Effects of PE film packaging on the trim loss, salability, quality and physiological disorders of stored cabbage (*Brassica oleraceae* L.)

處理 Treatment	貯藏期 Storage period (Month)	修整率 Trim loss (%)	可售率 Salability (%)	品質劣變和生理病害 Quality deterioration & physiological disorders				
				新鮮度 Freshness	莖纖維化 Fiberi-zation	黑心 Tip burn	膨脹度 Intumes-cence	黑點 Black leaf speck
塑膠袋打洞(對照) Perforated	3	36.9 b[a]	63.1 b	+[b]	+++	+	+++	+
預冷後密封 Sealed after precooled	3	73.6 a	26.4 c	++	++	+++	+	+
同上+ KM_nO_4 乙烯吸收劑 Sealed with KM_nO_4 ethylene absorbent after precooled	3	20.6 c	79.4 a	+++	−	−	−	+
田間密封+ KM_nO_4 乙烯吸收劑 Field sealed with KM_nO_4 ethylene absorbent	3	22.5 bc	77.5 ab	+++	−	−	−	+
同上 Ditto	4	30.4	69.6	+++	−	−	−	+
同上 Ditto	5	38.2	61.8	++	+	−	+	+

a. 同欄英文字母不同，表示達1%之顯著水準。
Means within column with no subscript letter in common are significantly different (P=0.01).

b. −：沒有 None；+：輕微 Slight；++：中等 Moderate；+++：强烈 Severe.

經3個月貯藏，發生苞葉膨脹 (Intumescence) 之劣化，亦以對照組最嚴重，封袋未加乙烯吸收劑處理者次之，加乙烯吸收劑者貯藏至5個月才發生輕微膨脹現象。葉片葉綠素分解以對照處理者最嚴重，貯藏3個月後，未腐爛之外葉已成黃色間雜些淡綠色，而內葉已成淡黃色，令人無新鮮的感覺，PE 袋封口未加乙烯吸收劑者次之，以封口加乙烯吸收劑者仍保持鮮綠。黑點生理病僅在甘藍二輪外葉發生，經修整後便已去除（表1）。

結球白菜之組織脆弱、呼吸率高，其貯藏力遠較甘藍爲低。以 PE 袋密封包裝，在極短時間內(20天)，袋內氧氣已降至1%以下，二氧化碳升高至 10 %，此種不利情況在 40 天後更爲明顯（圖2）。

結球白菜貯藏一個月時，苞葉仍然脆綠， 但2個月後， PE 封袋各處理之外葉已經輕微軟腐並發生異味，經室溫下放置2天，情形更爲嚴重。切開苞葉、心葉發生嚴重黑心生理病，完全失去商品價值。又葉柄形成離層與莖部分離，未加乙烯吸收劑者葉脈呈淡黃褐色。對照處理雖無此現象，但葉片失水，色澤較差，其修整損失已達 40 %，似無繼續貯藏之潛力。黑點生理病在貯藏1個月後即出現在各處理外葉上，2個月後更爲嚴重，除心葉數片外皆發生（表2）。

「成功」結球白菜經2個半月人工大氣貯藏後，其修整損失約在 50 %左右，較對照組 66.5 %爲輕，後者葉基部已形成離層，基部稍爲纖維化，葉片微黃，品質較差。人工大氣貯藏對上述品質劣

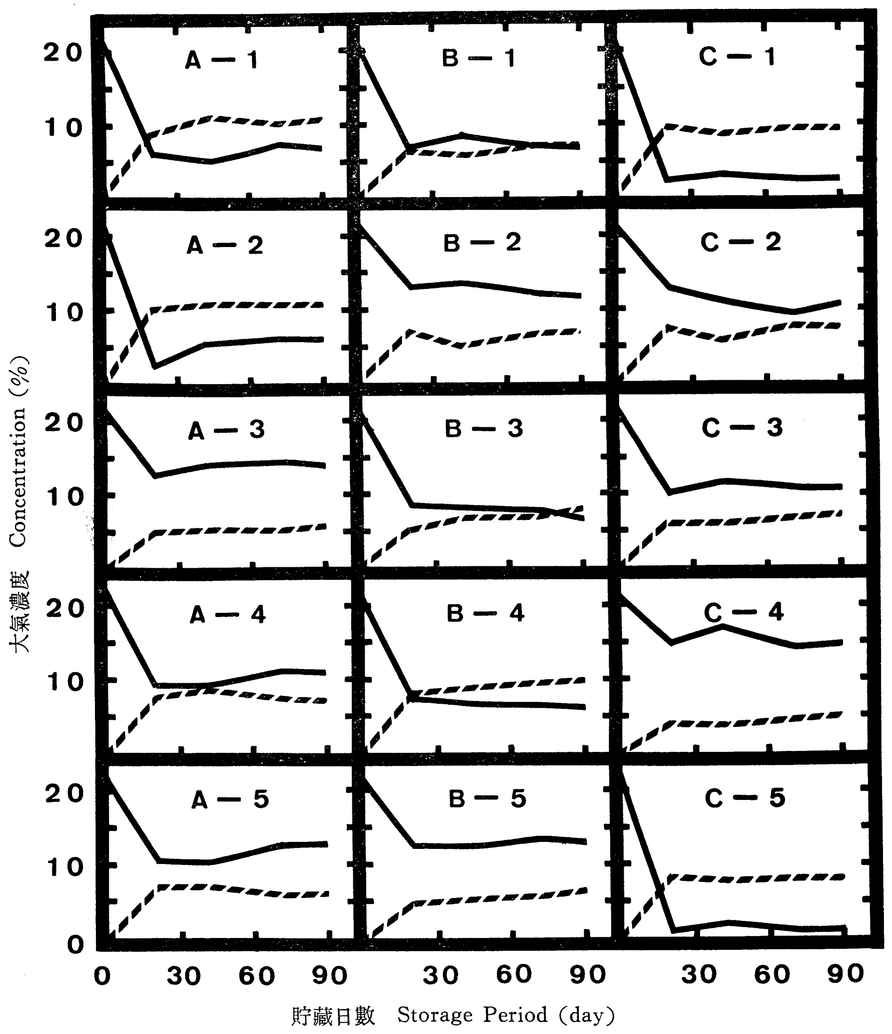

圖 1. 不同處理之甘藍密封包裝袋內大氣消長型式圖

Fig. 1. Pattern of changes in O_2 and CO_2 concentration in sealed cabbage PE bags

A＝隔夜預冷後密封。

Sealed after precooled overnight.

B＝隔夜預冷後加乙烯吸收劑密封。

Sealed with ethylene absorbent after precooled overnight.

C＝加乙烯吸收劑田間密封。

Field sealed with ethylene absorbent.

O_2：實線 Solid line；CO_2：斜線 Slant line.

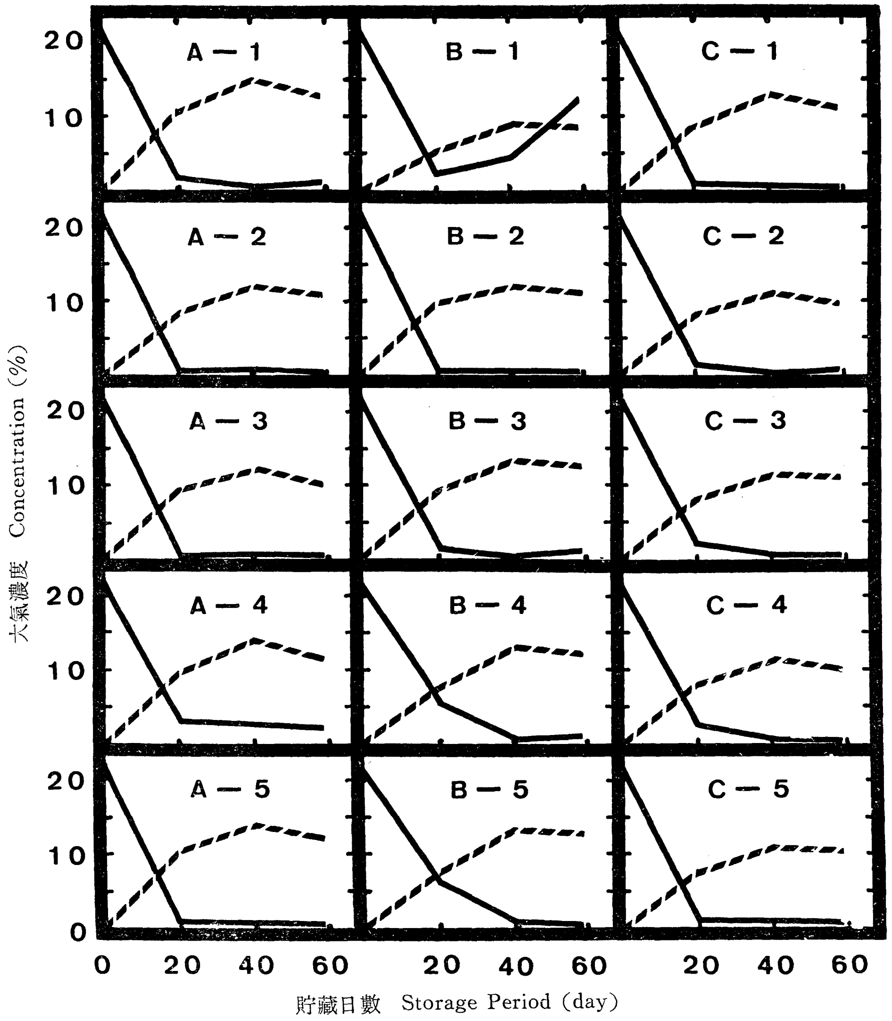

圖 2. 不同處理之結球白菜密封包裝袋內大氣消長型式圖。

Fig. 2. Pattern of changes in O_2 and CO_2 concentration in sealed Chinese cabbage PE bags.

A=隔夜預冷後密封。

Sealed after precooled overnight.

B=隔夜預冷後加乙烯吸收劑密封。

Sealed with ethylene absorbent after precooled overnight.

C=加乙烯吸收劑田間密封。

Field sealed with ethylene absorbent.

O_2 : 實線 Solid line ; CO_2 : 斜線 Slant line.

表 2. PE 塑膠袋包裝貯藏對「煙台」結球白菜修整率、可售率、品質與生理病害之影響

Table 2. Effects of PE film packaging on the trim loss, salability, quality and physiological disorders of stored Chinese cabbage (*Brassica pekinensis* Rupr.)

處理 Treatment	2 個月貯藏 修整率 Trim loss (%)	2 個月貯藏 可售率 Salability (%)	品質劣變和生理病害 Quality deterioration & physicological disorders 新鮮度 Freshness	莖纖維化 Fiberiza-tion	黑心 Tip burn	膨脹度 Intumes-cence	黑點 Black leaf speck
塑膠袋打洞 (對照) Perforated	33.9	66.1	+[a]	+	−	+	+++
預冷後密封 Sealed after precooled	100.0	0.0	++	+	+++	+	+++
預冷+KM_nO_4 乙烯吸收劑 Sealed with KM_nO_4 ethylene absorbent after precooled	100.0	0.0	+++	+	+++	+	+++
田間密封+KM_nO_4 乙烯吸收劑 Field sealed with KM_4O_4 ethylene absorbent	100.0	0.0	+++	+	+++	+	+++

a. −:無 None; +:輕微 Slight; ++:中等 Moderate; +++:嚴重 Severe.

變有抑制作用。但二氧化碳濃度高至5%時，白菜內部會有輕微黑心現象發生，黑點生理病的爲害程度較包裝試驗者爲輕 (表3) 。

表 3. 人工大氣貯藏對「成功」結球白菜修整率、可售率、品質與生理病害之影響

Table 3. Effects of controlled atmospheric storage of Chinese cabbage on the trim loss, salabiltiy, quality and physiological disorders

大氣濃度 Atmospheric composition O_2-CO_2 (%)	修整率 Trim loss (%)	可售率 Salability (%)	品質劣變與生理病害 Quality deterioration and physiological disodrers 新鮮度 Freshness	莖纖維化 Fiberiza-tion	黑心 Tip burn	膨脹度 Intumes-cence	黑點 Black leaf speck
21.0-0.03(air)	66.5 a[a]	33.5 b	+[b]	+	−	+	++
2.5-2.5	51.0 b	49.0 a	+++	−	−	−	++
2.5-5.0	53.9 b	46.1 a	+++	−	+	−	++
5.0-5.0	49.5 b	50.0 a	+++	−	+	−	++

a. 同欄英文字母不同表示達1%之顯著水準。

Means within column with no subscript letter in common are significantly different (p=0.01) .

b. −:無 None; +:輕微 Slight; ++:中等 Moderate; +++:嚴重 Severe.

討論與結論

如能有較進步的貯藏技術，本省甘藍可由目前2～3個月的貯藏壽命延長至6～7個月，以便在夏季時供應。本試驗應用冷藏配合乙烯吸收劑的使用，已延長甘藍貯運壽命達5個月之久，如能效法先進國家用人工大氣（2.5% O_2 及 5.0% CO_2）貯藏，使甘藍保鮮至7～9個月之久[18,19]時更能有效的供應夏季需求。本試驗以 PE 袋包裝甘藍，可控制袋內大氣成分氧濃度在1～12 %之間，二氧化碳在 10 %以下。袋間大氣成分變化差異程度頗大，其不易控制的原因是由於 PE 膜本身的差異大之故[3]，另外所裝材料成熟度及重量略有差異，亦爲原因之一。甘藍袋內大氣在上述情形下，雖非達到最佳組合，但對甘藍貯藏已顯然有利。本試驗中甘藍袋內氧有近於1%者，仍無發生無氧呼吸而造成醱酵之現象，二氧化碳有高達 10 %者，却無不利之影響。顯然甘藍對高二氧化碳及低氧的忍受性範圍很大。 Isenberg 氏經5年的控制大氣貯藏研究，指出氧氣在5—7.5 %之間爲甘藍有效臨界點（Breaking point），貯藏要在氧有效臨界點以下，無氧呼吸發生點（Oxygen extinction point）以上時，才較一般冷藏爲佳。而二氧化碳在5%左右時即具最佳的保綠（鮮）能力，超出此濃度，並無較好效果，此可以部份說明用 PE 袋包裝甘藍會有良好效果之原因。

預冷與否，對甘藍的貯藏效果不明顯，可能由於甘藍的呼吸率低，(約 3～4 ml/kg/hr），短期內不會造成袋內溫度過高，而影響其生理代謝之故。田間封口能保持較高濕度的情況，可抑制外葉失水而老化，增加抗病能力。此外預冷冷藏庫以蛇形氨管發冷產生對流式熱交換，此種預冷方式速率緩慢，效果不高，亦是另一原因。

甘藍在田間發生之黑心生理病已被證實與缺少鉀肥有關[24]，但在貯藏期發生之黑心生理病的原因，目前尚未明瞭。在萵苣上的心部褐化現象，經研究結果認爲與貯藏大氣、貯藏溫度、濕度及品種有關[6,21,29]。本試驗中置乙烯吸收劑處理者未發生黑心生理病，顯示黑心生理病之發生與乙烯有密切關係，可能是乙烯導致生理代謝之有害產物積聚所造成，症狀最先發生於心部，可能與心部組織最幼嫩與生理代謝最旺有關。

結球白菜對二氧化碳的忍受性遠較甘藍爲低，易發生高二氧化碳之生理障害 （High CO_2 injury）[32]。本試驗結果顯示，當二氧化碳濃度超過5%時，即發生不利之影響，易罹黑心生理病，此可用來解釋在包裝試驗貯藏中，袋內 CO_2 濃度在 10 %下達2個月之久爲造成全部黑心生理病的主要原因。黑心生理病與甘藍發生者相似，在心部發生乾腐，皆爲一種生理性之障害[16]。至於乙烯是否如同甘藍試驗影響黑心生理病的發生，於試驗中無法得知，因在連續流通之人工大氣貯藏試驗下，其乙烯並不積聚，而 PE 包裝試驗中，袋內氧過低及二氧化碳過高會使乙烯不能參與酵素反應[1]，或阻止乙烯之生成[34]，而掩蓋了乙烯之效果。

結球白菜黑點生理病的發生與貯藏溫度有關。試驗結果中顯示，在 5°C 貯藏較在 0°C 時發病爲低，此與前人報告相符合[27]。黑點生理病與萵苣的褐點生理病（Brown staining）相近似，後者係受過高之二氧化碳或過低之氧的影響而發生[6,9]，本試驗中，塑膠袋打洞之處理，亦會發生黑點生理病，顯非高二氧化碳或低氧之影響；此與乙烯似亦無關，因在連續流通之人工大氣貯藏中亦會發生，在此情況下，並無乙烯積聚，可能是因體內老化影響生理代謝的整體反應。

PE 膜包裝對甘藍之貯藏效果良好，而對結球白菜效果不好，概因後者呼吸率高，對氧消耗量與二氧化碳排出量大，但 PE 膜對氧及二氧化碳之滲透力有限，無法滿足其需要，因而造成無氧呼吸之情況之故。目前 EVA（Ethylene Vinyl Acetate resin）保鮮膜較 PE 膜約有5～6倍之氣體滲透能力且可製成較薄之厚度[5]，似較適合結球白菜之包裝貯運，此有待進一步觀察。

品種與貯藏力關係很大。在結球白菜試驗中使用之「煙台」與「成功」二品種，經2個月左右貯藏，其修整損失率達 50 %以上，遠較其他國家之品種爲高[7,12,28,32]，因此進行比較國內不同品種之貯藏力或以育種方式育成較耐貯藏品種之研究，在長期貯藏中頗具其意義。

引用文獻

1. 蔣明南・1970・香蕉密封包裝用乙烯吸收劑之研究。中國園藝 16(5)：14-22。
2. 林學正・1970・臺灣柑桔人工大氣貯藏之研究。嘉新文化基金會研究論文，第 244 種，36 pp.
3. 林學正・1974・控制透氣性包裝袋內大氣成分對新鮮水果蔬菜保鮮技術之研究。農業研究 23(1)：38-47
4. 周安祿、孫全鈞、廖武正・1977・臺灣區果菜冷藏設備及業務調查報告。中國農村復興聯合委員會 76-C32-R-490 計劃報告 58 pp.
5. 臺聚公司・1981・PE 與 EVA 在包裝上的正確使用方法。臺聚通訊 166： 2-3 。
6. Aharoni, N. and S. Ben-yehoshua 1973. Delaying deterioration of Romaine lettuce by vacuum cooling and modified atmosphere produced in polyethylene packaging. J. Amer. Soc. Hort. Sci. 98 (5) : 464-468.
7. Berg, L. Van dan, and Lentz, C. P. 1974. High humidity storage of some vegetables. Can. Inst. Food Sci. and Technology 7 : 260-262.
8. Bohling, H. and H. Hensen 1977. Storage of white cabbage (*Brassica oleracea* var. capitata) in controlled atmosphere. Acta Horticulture 62 : 49-53.
9. Brecht, P., Morris, L. Cheyney, C. and D. Janecke 1973. Brown stain susceptibility of selected lettuce cultivars under controlled atmospheres and temperatures. J. Amer. Soc. Hort. Sci. 98 : 261-264.
10. Brooks, C., Bratley C. O. and C. P. MacColloch 1936. Transit and storage disease of fruits and vegetables by initial carbon dioxide treatments. USDA Tech. Bull. 519, 24p.
11. Burg, S. P. and Ellen, A. Bürg 1962. Role of ethylene in fruit ripening. Plant Physiol. 37 : 179-189.
12. Emura, K. 1978. Effect of storage temperature on the quality and some components of Chinese cabbage (*Brassica campestris* L. var. pekinensis Makino). Bull. Saitama Hort. Exp. Stat. No. 7 : 41-47.
13. Francis, F. J. 1960. Discoloration and quality maintainance in cole slaw. Proc. Amer. Soc. Hort. Sci. 75 : 449-455.
14. Geeson, J. D. and K. M. Browne 1979. CA keeps coleslaw crop greener. Grower 92(14) : 36-38.
15. Geeson, J. D. and K. M. Brown 1979. Effect of postharvest fungicide drenches on stored winter white cabbage. Plant Phthology 28(4) : 161-168.
16. Glaeser, G. 1979. Non-parasitic storage disorders of cabbage and Chinese cabbage. Pflanzenarzt 32(4) : 42-44.
17. Henze, J. 1977. Influence of CA-storage on fermentation of white cabbage (*Brassica oleracea* L.). Acta Horticulture 62 : 71-76.
18. Isenberg, F. M. 1969. Fresh green cabbage--after seven monthes of storage. Amer. Veg. Grow. 17(2) : 24, 26, 48-49.
19. Isenberg, F. M., and R. M. Sayles 1969. Modified atmosphere storage of Danish cabbage J. Amer. Soc. Hort. Sci. 94(4) : 447-449.
20. Isenberg, F. M., Oyer, E. G., and C. B. Engst 1971. The effects of modified atmospheres plus physioligically active chemicals on cabbage storage life. Acta Horticulture 20 : 7-18.
21. Lipton, W. J. 1967. Market quality and rate of respiration of head lettuce held in low-oxygen atmosphere. USDA Mkt. Res. Rpt. 777.
22. Lutz, J. M. and R. E. Hardenburg 1968. The commercial storage of fruits, vegetables and florist and nursery stocks. USDA Agri. Handbook No. 66, 94p.
23. Nelson, R. 1926. Storage and transportational diseases of vegetables and suboxidation. Mich.

Agri. Exp. Stat. Tech. Bull. 81, 38pp.

24. Palmer, R. G. 1941. Effects of potash on the tip burn of cabbage. Phytopathology 31 : 18.
25. Parsons, C. S. 1959. Effect of temperature and packaging on the quality of stored cabbage. Proc. Amer. Soc. Hort. Sci. 74 : 612-621.
26. Parsons, C. S. 1959. Extending the storage life of cabbage, celery, lettuce and tomatoes abroad a navy supply ship. USDA, Mkt, Res. Rept. 336.
27. Pastnkhor, V. M. 1977. The effect of temperature and relative humidity during storage on the occurrence of spotted necrosis on head cabbage mother plants. Shorik Nach. Trudor Mosk, S-Kh, Akad. im-K. A. Timiryaszeva No. 231 : 145-147. (Cited in Hort. Abs. 49(2) : 100, 1979).
28. Schouten, S. P. 1979 CA storage of Chinese cabbage. Groenten en Fruit 35(17) : 46-47. (Cited in Hort Abs. 50(5) : 280, 1980).
29. Stewart, J. K., and F. Motoba 1972. Some factors influcing the suceptibility of lettuce to CO_2 injury. Plant Disease Reporter 56 : 1051-1053.
30. Tomkins, R. G. 1962. Film packaging of fresh fruit and vegetable--the influence of permeability. The lnst. Packaging Conf. Guide, pp. 64-69.
31. Tomkins, R. G. 1962. The conditions produced in film packaging fresh fruits and vegetables and the effect of these conditions on storage life. J. Appl. Bact. 25(2) : 290-307.
32. Weichmann, J. 1977. CA storage of Chinese cabbage (*Brassica pekinensis* (Lour) Rupr). Acta Horticulture 62 : 119-129.
33. Wells, J. M. 1974. Growth of *Erwinia Carotovora, E. atroseptica* and *Pseudomonas fluorescens* in low oxygen and high carbon atmospheres. Phytopathology 64 : 1012-1015.
34. Yang, S. F. 1980. Regulation of ethylene biosynthesis. Hortscience 15(3) : 238-243.

Long-term storage of cabbage and chinese cabbage[1]

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Summary

'Chu-chiuo' cabbage and 'Ien-tai' Chinese cabbage were packed in 0.03m/m thick polyethylene (PE) bag for 2-5 month storage. KM_nO_4 on vermiculite as ethylene absorbent inhibited the quality deteriorations of cabbage as leaf yellowing, stem fiberization and sprouting, head intumescence and physiological disorder of tip burn, however, disorder of black leaf speck was not alleviated. Disorder of tip burn was seriously appeared

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in the treatment without ethylene absorbent after 3-month storage. Packaging with ethylene absorbent kept cabbage in freshness for 5 months compared with the mere acceptable condition in perforate package for 3 months.

Ethylene absorbent had no significant benefcial effect in inhibiting quality deterioration and physiological disorders in Chinese cabbage due to the commodities were injured with high CO_2 (>10%) and low O_2 (<1 %). Disorder of black leaf speck was appeared seriously in leaves after 1-month storage.

The concentration of O_2 and CO_2 in cabbage packagings attained their steady-state after 20-day storage. The flucturations of O_2 were ranged between 1-12%, whereas CO_2 were 4-10% ; Steady-state condition were not happened in Chinese cabbage packagings in which CO_2 increased sharply till 40-day storage then declined due to decay or fermentation, O_2 decreased lower than 1% after 20-day storage and keep till 60 days.

Another cultivar 'Chen-kon' chinese cabbage were stored under controlled atmosphere with combinations of O_2 2.5%-CO_2 2.5%, O_2 2.5 %-CO_2 5 %, and O_2 5 %-CO_2 5%. Controlled atmosphere storage had good results both in increasing salability and quality keeping, however, CO_2 concentration of 5 % increased the disorder of tip burn. The best combination for Chinese cabbage was found in 2.5% O_2 and 2.5 % CO_2.

中華農業研究 (Jour. agric. Res. China) 30(4)：405～411 (1981)

水田滿江紅 *Azolla pinnata* 之研究

I. 環境因子對滿江紅生長之影響[1]

李啓彰　林錫錦　林家棻[2]

摘要：本文所用之滿江紅係屬省產之 *Azolla pinnata*，其體內水份約佔鮮重 91～92%，乾物內含高量的氮 (4.4%)、鉀 (2.4%) 等元素。
在 5 ppm Fe (EDTA-Fe) 濃度下，滿江紅在各種培養液內都生長良好，其中 Hoagland, 2/5 conc. Hoagland 及 Tollens 培養液生長更佳。在各培養液不加鐵的情形下，滿江紅鮮重雖然增加，但株體變黃，體內含氮量降低。去氮 Tollens 培養液亦很適合滿江紅生長與增殖。光照在 9000 lux 以上滿江紅生長良好，在 12000 lux 以上生長呈飽和狀態。對溫度適應而言，在 40°C 時培養 2 天即告死亡， 35°C 時生長緩慢，30 至25°C 間生長良好。pH 值的適應範圍在4.5～8.5之間，以 pH 5.5 時生長情形最佳。滿江紅並具有中和培養液酸鹼之特性，可使培養液 pH 值低者提高，高者抑低。

滿江紅爲水生蕨類植物，屬槐葉蘋目，滿江紅科，滿江紅屬。屬內有 6 種，臺灣原產有 *Azolla pinnata* 一種[1]。

滿江紅株體生長非常迅速，又因葉內有藍藻 *Anabaena azollae* 共生，因此具有極强的固氮力[4,12]。據 Rains 及 Talley[11,14] 估計，滿江紅生長 35 天的固氮量約 35 kg/ha，46 天的固氮量約爲 93 kg/ha。近年來由於能源危機，化學氮肥之製造成本大爲提高，利用天然綠肥來減少化學氮肥使用之研究相當盛行。滿江紅可與水稻共作，不受土地限制影響，因此其經濟價値正逐漸被重視中。

臺灣地處亞熱帶，原產即有 *Azolla pinnata* 一種，環境很適合滿江紅之生長。過去常被忽視。近年來更由於殺草劑大量使用滿江紅生存受到極大威脅。在這種情況下欲將滿江紅應用於本省水田將面臨非常複雜的問題。但在能源缺乏之下，滿江紅不失爲一種新能源，値得加强研究。

目前國內有關滿江紅之研究不多，滿江紅養殖之基本資料尙付闕如。因此本研究擬自生態因子對滿江紅生長及固氮影響着手，以爲日後更進一步養殖滿江紅提供施用之參考。

材料與方法

滿江紅成分分析：水份用 105°C 烘乾法，直至恆重爲止，氮素用 Kjedahl's[2] 法，其他要素則將烘乾滿江紅灰化後[2]，磷用鉬藍法，鉀用焰光法，鈣及鎂用原子吸光法。

培養液之篩選：選用之培養液計 1. Hoagland[5] 2. $\frac{2}{5}$濃度 Hoagland, 3. Tollens[3,6], 4. Pfeffer[3,6] 5. Line and Loutit[8] 6. 去氮之 Tollens。各種培養液均添加 1 ml/l 之 EDTA-Fe[6]（其鐵濃度約爲 5 ppm），另加 0.1 ml 微量元素液[5]。上述各培養液裝於 19×24 cm 塑膠盆中，每盆 1,500 ml

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1. 臺灣省農業試驗所 研究報告 第 1019 號 。 本文之滿江紅經由中興大學植物系講師蔡進來先生協助採得，謹此致謝。
2. 臺灣省農業試驗所農業化系助理、研究員、研究員兼主任。臺灣省 臺中縣 霧峰鄉。

。滿江紅接種量爲每盆 0.5 g。各處理 5 重複，於溫室內培養，每 5 天換新鮮培養液，至 20 天後量取全部鮮重。接種前及收獲時並法測定各處理滿江紅體內之含氮量。

光度試驗：去氮之 Tollens 培養液裝於容積爲 680 ml 之黙滴瓶中，每瓶 500 ml，並接種 0.3 g 之滿江紅，置於光度爲 9000 lux 之日光燈下 1 小時後以乙炔還原法測定固氮力[8]（乙炔分壓約爲14%）後打開瓶塞，再分置於 0、1000、3000、6000、9000、12000、15000 lux 等 7 種光照下培養。每處理重複 5 次，培養 3 天後再測定各處理之固氮力，並量取其鮮重。

鐵濃度對滿江紅生長及固氮力之影響：去氮之 Tollens 培養液內分別以 EDTA-Fe 加入 0、2、5、10、20 ppm 等 5 種濃度之 EDTA-Fe，每濃度 5 瓶，每瓶 500 ml，全部處理共 25 瓶，於 9000 lux 光照下培養 4 天後稱取鮮重並測定固氮力。

溫度對滿江紅生長之影響：所用培養液及接種量與光度試驗相同，在 9000 lux 下分別置於15、20、25、30、35 及 40°C 水浴箱內培養滿江紅而於第 3 天稱取各處理鮮重。

pH 值對滿江紅生長之影響：接種量同光度試驗，去氮之 Tollens 培養液以 IN 之 HCl 及 KOH 調成3.5、4.5、5.5、6.5、7.5、8.5 及 9.5 等不同 pH 值，每一 pH 值處理重複 3 次，於培養後第 3 及 7 天稱取滿江紅鮮重並測定培養液之 pH 值。

結　　果

滿江紅之成分分析：本研究所用滿江紅之含水量約占鮮重之 91～92%，含氮量約占乾重之 4.4%（粗蛋白約爲 28.6%），碳水化合物約爲乾重之 38.5%，此外並含相當量之鉀（2.4%）鈣（1.2%）等（表 1）。以上各成分受培養情況之影響而有所不同。

表 1. 滿江紅成分分析表

Table 1. Analysis of *Azolla pinnata* (Da Li Clone)

Analysis	%
Water	91-92
Dry matter	8-9
Total carbohydrates	38.5
Raw protein	28.6
Total nitrogen (N)	4.4
Potassium (K)	2.4
Calcium (Ca)	1.2
Phosphorus (P)	0.8
Magnesium (Mg)	0.6

滿江紅培養液：本試驗以 5 種常用植物及固氮微生物培養液培養滿江紅後發現，除 Pfeffer 培養液外，滿江紅在其他有氮源及無氮源之培養液內都能生長，而以 Hoagland, $\frac{1}{2}$ conc Hoagland, 有氮源Tollens 及無氮源 Tollens 培養液較佳，20 天後不但鮮重增參了二十多倍，體內含氮量也比原來要高表(2)。但培養液內的鐵源若不以 EDTA-Fe 取代，則全部的生長情形都差。另外以不同濃度 E DTA-Fe 處

理滿江紅時發現 2 ppm 以上 EDTA-Fe 即可使滿江紅生長良好。而不加 EDTA-Fe 時滿江紅鮮重仍能增加，不過增加的鮮重及固氮力都較差，而且培養後滿江紅株體變黃，含氮量降低甚多（表 3）。

表 2. 培養液對滿江紅生長之影響

Table 2. Effects of nutrient solutions on the growth of the azolla

Solutions	Days after cultivation			
	0		20	
	fw	%N[a]	fw	%N
Hoagland solution	0.5	4.4	13.6	4.95
2/5 conc. Hoagland solution	0.5	4.4	14.2	4.98
Tollens solution	0.5	4.4	13.4	4.80
Tollens solution (-N)	0.5	4.4	13.1	4.52
Line and Loutit solution	0.5	4.4	10.4	3.66
Pfeffer solution	0.5	4.4	—[b]	—

a. On dry weight basis.
b. Death of azolla.

表 3. 不同濃度鐵（EDTA-Fe）對滿江紅生長之影響

Table 3. Effects of iron concentrations on the growth of the azolla

Fe conc. (ppm)	Days after cultivation				
	0		4		Final %N[c]
	fw[a]	N_2 fixed[b]	fw	N_2 fixed	
0	0.3	95.2	0.66	73.2	3.8
2	0.3	100.1	0.83	124.6	4.6
5	0.3	92.3	0.83	131.6	4.9
10	0.3	84.4	0.78	123.8	—[d]
20	0.3	85.7	0.77	113.5	—

a. Fresh weight, gram.
b. n mole C_2H_4/0.1g fw/hr.
c. On dry weight basis.
d. No data.

環境因子之影響：滿江紅在日光燈照度 3000 lux 以下生長不佳，固氮力亦低， 9000 lux 以上生長良好， 12000 lux 以上生長與固氮力似呈飽和情形，6000 lux 以下生長情形稍差（表 4）。

又實驗中得知，滿江紅之固氮力與光照呈立即性的反應。因此在不同光度下一小時內固氮力即有明顯不同（表 4）。另外在 9000 lux 室溫下，滿江紅之固氮量與時間呈直線關係（圖 1）。溫度對滿江紅生

表 4. 光照對滿江紅生長之影響

Table 4. Effects of illuminations on the growth of *Azolla pinnata*

Illumination (lux)	Days after cultivation				
	0			3	
	f. w. [a]	N_2 fixation[b]		f. w. [a]	N_2 fixation [b]
0	0.30	90.4[c]	14.7[d]	0.24	0.0
1000	0.30	92.1	53.4	0.45	63.8
3000	0.30	87.5	80.0	0.52	98.2
6000	0.30	97.0	94.7	0.61	98.0
9000	0.30	97.0	98.4	0.66	116.8
12000	0.30	90.0	—	0.70	126.2
15000	0.30	102.3	—	0.71	128.6

a. Fresh weight, gram.

b. n mole C_2H_4/0.1g f. w/hr.

c. Before illumination treatment.

d. After illumination treatment.

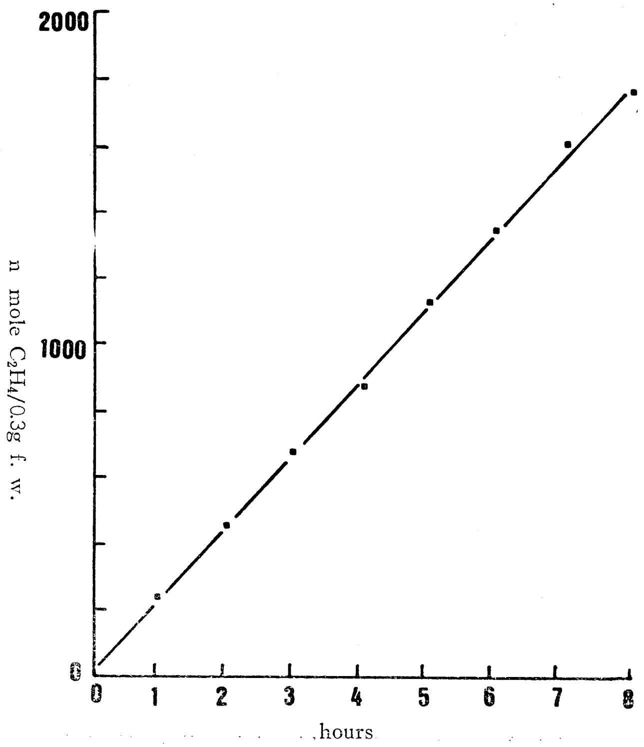

圖 1. 滿江紅固氮力與時間呈直線相關

Fig. 1. Linear correlation between nitrogen fixation of *Azolla pinnata* and the time course of growth

長之影響甚大，在 40°C 時，2～3天內大部份滿江紅即已死亡，少數倖存者亦呈碎片狀，不見增殖情形。35°C 時滿江紅不會死亡，但鮮重增加不多，3天內只增加 60% 左右。滿江紅在 25°C 及 30°C 時生長最好，3天內鮮重增加了2倍以上。滿江紅在 20°C 溫度以下生長情形變差，3天內鮮重只增加 30～90% 左右（表5）。滿江紅對 pH 值的適應範圍在 4.5～8.5 之間，而以 5.5～6.5 之間滿江紅鮮重增加最顯著。又培養後各培養液其 pH 值都趨向中性（表6）。

表 5. 溫度對滿江紅生長之影響

Table 5. Effects of temperatures on the growth of the azolla

Temperatures (°C)	Fresh weight of azolla at initiation (g)	Fresh weight of azolla after 3 day's growth (g)
15	0.30	0.40
20	0.30	0.58
25	0.30	0.84
30	0.30	0.70
35	0.30	0.50
40	0.30	—[a]

a. Death of azolla

表 6. 不同 pH 值對滿江紅生長之影響

Table 6. Effects of pH values on the growth of the azolla

Days after cultivation					
0		3		7	
pH [a]	f. w. [b]	pH	f. w.	pH	f. w.
3.5	0.30	3.8	0.30	4.0	0.19
4.5	0.30	4.6	0.52	5.1	0.61
5.5	0.30	5.5	0.62	5.6	0.89
6.5	0.30	6.3	0.60	6.4	0.64
7.5	0.30	7.4	0.60	7.0	0.63
8.5	0.30	7.5	0.56	7.2	0.61
9.5	0.30	8.4	0.40	7.6	0.43

a. pH values of Tollens solution (−N)

b. Fresh weight, gram

討　　論

本文所用之本地種滿江紅其生長與增殖速度非常快，在接種後2星期內鮮重往往可增加爲原來的 15 ～20 倍。而在長滿水面後能繼續以疊層（mutiple layers）的方式增殖。據筆者在溫室估計其疊層數在 45 天後爲4層左右，但田間估計在5～6層之間。由於高含氮量，高生長速率及高疊層數，筆者認爲本地種的滿江紅當可成爲非常好的水田綠肥。

已知之六種滿江紅中以 *Azolla pinnata*, *A. mexicana*, *A. caroliniana* 及 *A. filiculoides* 等較常被用作研究材料。 IRRI 於 1978 年[7]研究報告指出 *A. pinnata* 在日夜溫度 37/29°C 高溫下生長速度及單位面積固氮量都要比 *A. filiculoides* 及 *A. mexicana* 好得多。但在 29/21°C 下 *A. filiculoides* 之生長情形比 *A. pinnata* 略好。不過就田間養殖而言，*A. pinnata* 在 IRRI 之生長情形似乎較 *A. filiculoides* 爲優。本省地處亞熱帶， 是 *A. pinnata* 的原產地之一，因此就環境適應而言，養殖 *A pinnata* 應是很適合的。

一般滿江紅對溫度及光照都很敏感，Becking (1976)[4]指出 *A. pinnata* 之固氮力在 14 klux 至 27 klux 間並無區別，而白天日照達 80～90 klux 時 *A. pinnata* 固氮力明顯降低。但黑暗情形下 *A. pinnata* 固氮力在一小時後即接近於0 。Peters (1976, 1978)[9,10]研究 *A. caroliniana* 時發現其固氮力在 4840 lux 時即可呈飽和情形，顯然與 *A. pinnata* 有很大的不同。本研究所用之 *A. pinnata* 在 9000 lux 光照時固氮力頗佳，12000 lux 以上似呈飽和情況。不過在田間，固氮力受光照影響之情形則有待進一步實際去探討。溫度方面據 Watanabe (1977)[15]研究 *A. pinnata* 時發現在 26/18，與 31/24 °C 水溫時其生長情形都相差不遠，但在 35/27°C 時生長降低了 50% 左右。不過越南農民所用之 *A. pinnata* 在溫度超過 22～24°C 即會死亡[13]，兩者耐熱能力差異甚大。本文所用之 *A. pinnata* 在 30°C 時仍生長的很好，顯然爲耐熱品系。由於 *A. pinnata* 不同品系之間可能有不同的耐熱力。就本省氣候而言，二期作之氣溫偏高，因此相當須要耐高熱品系之滿江紅 。本文之 *A. pinnata* 品系在 35°C 時生長速度急劇下降，是否適於二期作使用，有待證明 。 滿江紅對低溫適應性亦差， Aham[4] 研究 *A. filiculoides* 時發現 20°C 以下生長情形不佳，Gopal[4]亦觀察到 *A. pinnata* 在印度，無法以株體越冬。本省最低溫大多在每年一至二月間發生，二月以後溫度即逐漸回升。由於嚴寒時間不長，因此對一期作而言，可能更利於滿江紅之使用。不過既然滿江紅各品種，品系間對溫度適應有差異，也許尋找或培育出耐高溫及耐低溫品系分別供應一、二期作之需要將是比較實際之方法。

在 pH值 適應方面，本研究所用之 *A. pinnata* 適應範圍在 4.5～8.5 之間，而以 5.5 最佳，與 Watanabe (1977)[15] 之結果相似。本研究亦發現滿江紅有中和環境中過酸或過鹹的 pH 值的效果，此一效果是否見於田間仍有待證明。

滿江紅生長所需元素以 P. Mg. Fe等最爲重要，其中 Fe 缺乏造成滿江紅生育不良最易被忽視。尤其以培養液養殖時，更須注意 Fe 源問題。由於各地水質之 pH 值不同，影響一般氯化鐵、硫酸鐵之有效性甚鉅，因此，本研究以 EDTA-Fe 當鐵源而使滿江紅在各種培養液內大多有相當好的生長情形。

參 考 文 獻

1. 中山自然科學大辭典・1972・第8卷・植物學・：600・商務書局。
2. 包伯度・鄭雙福・1976・肥料學：222-226・遠東圖書公司。
3. 陳大武・1970・眞菌學實驗・：168 國立中興大學植病系講義。
4. Becking, J. H. 1979. Enviromental requirements of *Azolla* for use in trorpical rice production *In* Nitrogen and Rice : 345-375. IRRI.
5. Gamborg, O. L. and L. R. Wetter. 1975. Plant tissue culture methods, p. 41, 46, 92.

6. Hewitt, E. L. 1966. Sand and water culture methods used in the study of plant nutrition. : 190-230. Commonwealth Agricultural Bureau.

7. IRRI. 1978. Annual report for 1978. : 245-246. IRRI.

8. Lin, C. J. 1975. Nitrogen fixation, nitrogen metabolism and microbial population in the rhizosphere of the selected grasses, 28 pp. Ph. D Thesis, University of Idaho.

9. Peters, G. A., W. R. Evans., and R. E. Toia. Jr. 1976. *Azolla-Anabaena azollae* relationship. Plant Physiology 58 : 119-126.

10. Peters, G. A. 1977. The *Azolla-Anabaena* Symbiosis *In* Genetic Engineering for Nitrogen Fixation : 231-258. Plenum Press.

11. Rains, D. W. and S. N. Talley. 1979. Use of *azolla* in north American *In* Nitrogen and Rice : 417 -431. IRRI.

12. Shen, Y. F. 1960. *Anabaena azollae* and its host *Azolla pinnata*. Taiwania 7 : 1-7.

13. Sprent, J. I. 1979. The biology of nitrogen fixation organisms. : 37-49 McGraw-Hill Book Com- any.

14. Talley, S. N. and B. J. Talley. 1977. Nitrogen fixation by *azolla* in rice field *In* Genetic Engineering for Nitogen Fixation : 259-281. Plenum Press.

15. Watanabae, I., C. R. Espinas., N. S. Berja and B. V. Alimagno. 1977. Utilization of the *Azolla-Anabaena* complex as a nitrogen fertilizer for rice. IRRI. Res. Pap. Ser. 11. 15 p.

The use of *Azolla pinnata* in rice paddies

I. The influences of enviromental factors on the *Azolla pinnata*[1]

C. C., Lee, C. J. Lin and C. F. Lin [2]

Summary

A local veriety of *Azolla pinnata*, with high content of nitrogen, and potassium was collected for the current study.

With the addition of 5 ppm EDTA-Fe in every nutrient solution, the azolla grew and developed well, especially in Hoagland, 2/5 conc. Hoagland, Tollens and Tollens (−N) solutions. The absence of EDTA-Fe in solutions caused poor growth in all solutions used. Optimum growth was reached at light intenses above 9000 lux with maximum growth at 12000 lux. 40°C was detrimental to the azolla. Above 35°C or below 20°C retarded the growth of the azolla. 25-30°C improved growth condition of the azolla. Suitable pH values ranged between 4.5-8.5, while the most suitable pH value was 5.5. The azolla also showed an ability to neutralize pH values of acidic or basic solutions after cultivation.

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Ecological studies of asiatic citrus psyllid (*Diaphorina citri* K.) with special reference to its spatial distribution[1]

Chin-ling Wang[2]

Abstract: Experiments on spatial distribution of asiatic citrus psyllid (*Diaphorina citri* Kuwayama) were conducted at Taiwan Agricultural Research Institute from the winter of 1979 to the summer of 1981. Forty 4th or 5th instar nymphs of asiatic citrus psyllids were introduced on 240 pot-raised citrus saplings (*Citrus reticulata* var. *Suenkat*) in greenhouse. The highest mean density observed was 57.1 nymphs per sapling. The relative degree of aggregation (m^*/m) was high during the low population density period when *D. citri* was just introduced into greenhouse, and declined as the population density increased. This figure tended to be stable when the insect has been introduced into greenhouse for more than 2 months. The m^*-m relationship in nymphal and adult populations were expressed as $m^*=3.86+2.83m$, and $m^*=5.86+1.33m$, respectively. Both nymph and adult aggregated to form colonies as distribution units and the units with random inntra-colony distribution distributed contagiously. The colony area ranged from 1 to 4 saplings.

Naturally occurring *D. citri* in field had m^*-m relationship as $m^*=0.73+2.46m$ for nymph and $m^*=0.76+2.23m$ for adult. Both nymph and adult had smaller unit colonies in field than in greenhouse. The distribution of nymph and adult in field had similar aggregation tendency. The colony area in field was approximately 1-2 branches.

The asiatic or oriental citrus psyllid, *Diaphorina citri* Kuwayama (Homoptera: Psyllidae), distributed primarily in tropical and subtropical Asia, has been reported causing serious damage to citrus [(7)]. The damage results from the growth of sooty mold on psyllid honeydew covered leaves, and transmission of the pathogen that causes greening disease [(6)]. The psyllid is a very destructive pest and has played an important role in citrus production [(4)].

This study was initiated to investigate the population buildup in greenhouse, population flunctuation in field, and characteristics of spatical distributions. These informations are valuable for understanding the population of asiatic citrus psyllid and essential for developing sampling plan for its management.

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Materials and Methods

Experiment was conducted at Taiwan Agricultural Research Institute from the winter of 1979 to the summer of 1981. In greenhouse, two hundred and forty 3-year-old citrus saplings (*Citrus reticulata* var. *Suenkat*) of about 50cm high with 3-5 branches were planted individually in pot (dia. 24cm). Pots were arranged in a square-grid pattern of 12 rows and 20 lines in an area of $3.8 \times 6.3m^2$(Figure 1). Forty 4th or 5th instar psyllid nymphs were evenly introduced on 8 randomly selected plants on 18 December 1979. Observations on the population distribution and buildup were started on 18 January and terminated on 30 June 1980. Number of psyllid were counted twice a week during this period. Temperature and humidity were recorded during the experimental period.

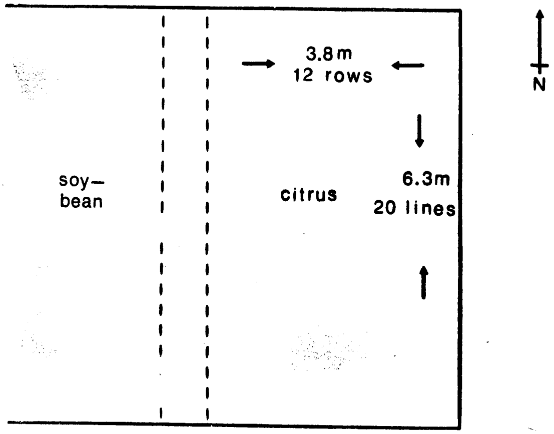


Fig. 1. Diagram of test area in greenhouse.

Field observations were made at 0.5 acre of citrus orchard with 3-year-old saplings of about 180cm high in TARI experimental field. No insecticide was applied in this orchard for at least 3 months prior to the observations as well as throughout the experimental period. The orchard was divided into four blocks, 20 branches were randomly selected over the whole area. Populations of naturally occurring asiatic citrus psyllid were sampled during 1980 and 1981.

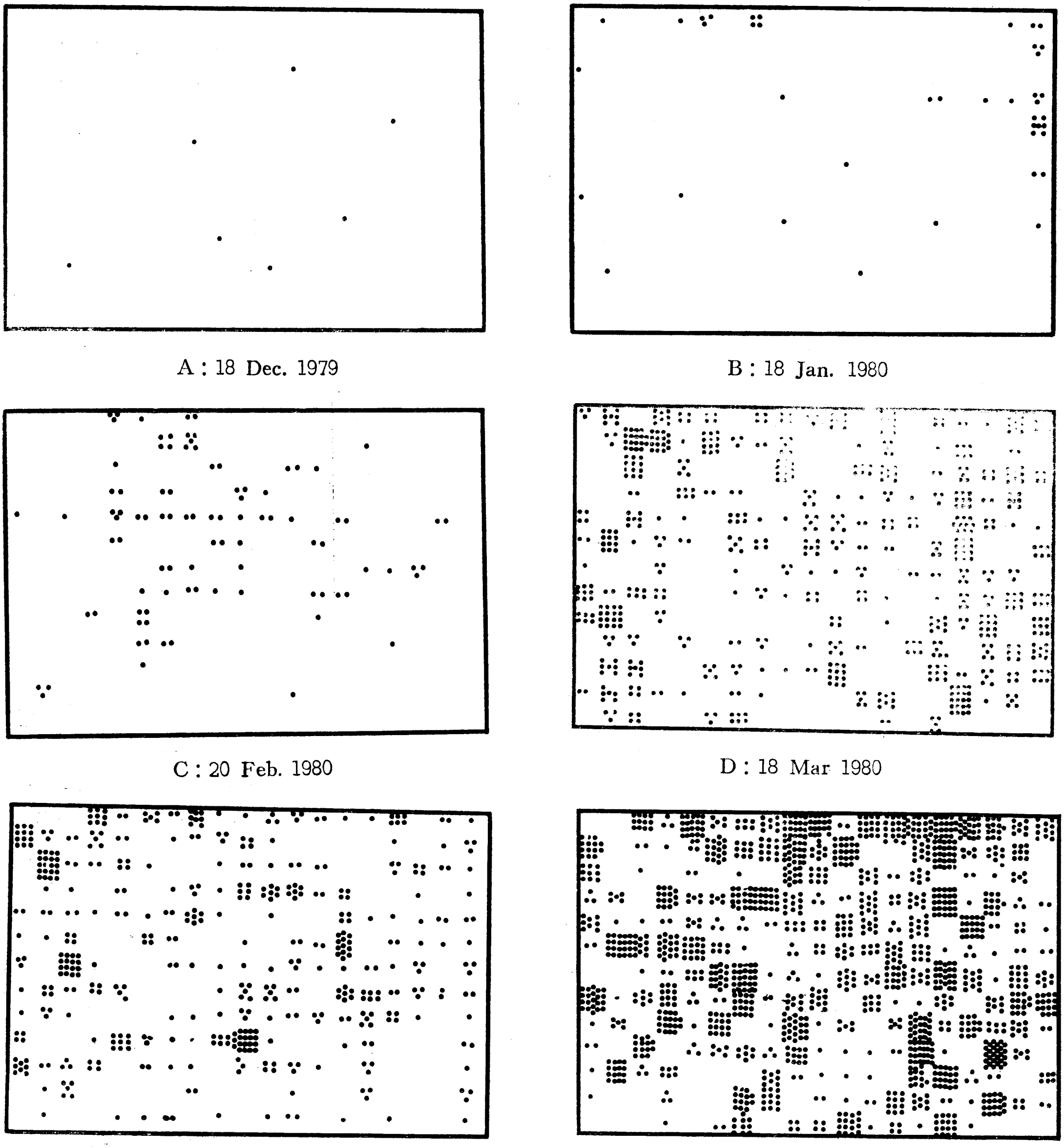
Tendency of aggregation of insect population was measured by Lloyd's patchiness, m^*/m, where m^* is the mean crowding and m is the mean density of the species. Mean crowding is defined by Lloyd as the mean number of other individuals per individual per quadrat. It relates to the mean density and the variance (σ^2) of the population in the following way: $m^* = m + (\frac{\sigma^2}{m} - 1)$.

Type of dispersion was detected by series and unit-size m^*-m relations. Series m^*-m relation can be expressed by a linear regression equation: $m^* = \alpha + \beta m$, where α and β are the constant characteristics of the distribution of the species concerned. Unit-size m^*-m relation is obtained by successive changes of quadrat size for a single population.

The parameter ρ is given by $\rho=\frac{m_i^*-m^*_{i-1}}{m_i-m_{i-1}}$ where i stands for the ascending order of quadrat size.

Results and Discussion

Figure 2 illustrats the successive population changes of *D. citri* in greenhouse. Figure 2 (A) shows the inoculation sites and the others (B, C, D, E, F) illustrate the situation in the 2nd, 3rd, 4th, 5th and 6th month. The population build up and the agg-



A : 18 Dec. 1979

B : 18 Jan. 1980

C : 20 Feb. 1980

D : 18 Mar 1980

E : 22 Apr. 1930

F : 13 May 1930

Fig. 2. Successive changes of nymphal dispersion of *D. citri* in greenhouse. Drawings are made based on data on the specified date. Each dot stands for 5 nymphs.

regation pattern changes can be compared in those Figures of that order.

Figure 3 shows the population changes of asiatic citrus psyllid nymph in greenhouse. Following the inoculation, there was a gradual population buildup which first peaked at a density of 15.6 nymphs per plant on 14 March. Thereafter the population declined sharply. The sharp decline following the first peak was due to the gradual dieback of buds caused by the psyllid feeding thereby reducing the food and possibly shade for

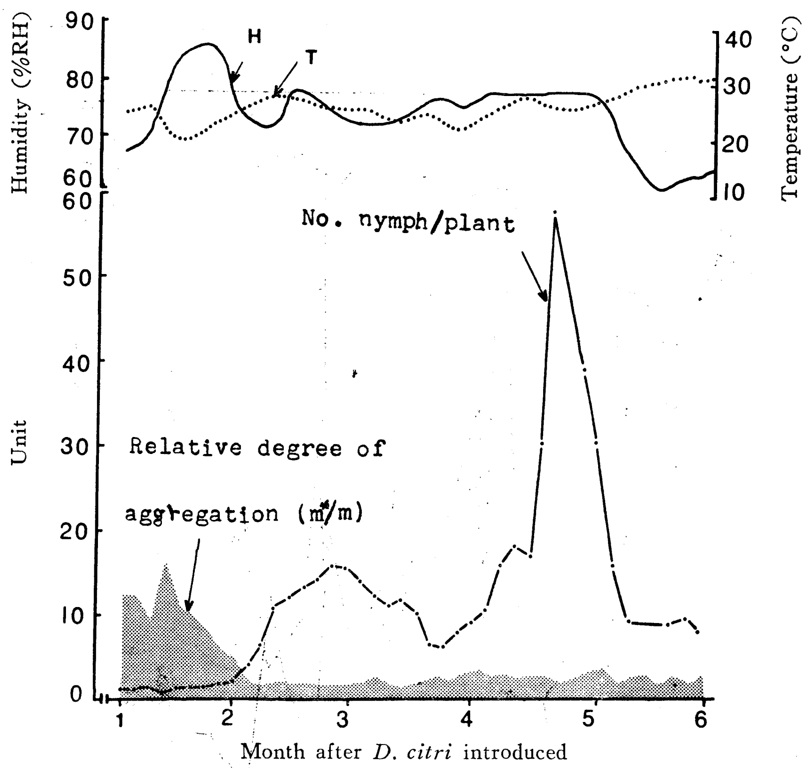


Fig. 3. Population fluctuation and relative degree of aggregation of *D. citri* nymph in greenhouse.

their survival. During the low-population period, citrus plants put out fresh growth, mainly new branches, usually abnormal and brushy type which supplied large amount of food and habitat for the psyllid. With the rapid increase of food and habitat, the number of young psyllid increased almost exponentially to a peak density of 57.1 nymphs per plant during the first week of May. Following the second peak, the density dropped drastically to 8-9 nymphs per plant and stayed around at that level for quite a while. Meanwhile as the result of their feeding most of the young leaves were found seriously damaged. From the observations it was evident that citrus flushing is the main factor influencing the population buildup of the insect in greenhouse. With better plant growth in terms of abundance of new leaves, the insect population would increase and it decreased only when the young leaves were exhausted.

The m*/m value was plotted against sampling date at the bottom of Figure 3. The first value was 12.6 obtained on 18 January. This value increased to 13.4 then declined continuously in the following 6 surveys. The decline of m*/m value terminated at the point of 2.1 when the nymphal density exceeded 6.2 per sapling, i. e., total number

of nymph exceeded 1495. The decrease of the m*/m value revealed that the distribution became less contagious along with the growth of population. After this declining period, the m*/m values became stablized suggesting thereby that the aggregation of distribution was not affected by the growth of population any more. In other words, the change of mean density did not influence the degree of aggregation.

Figure 4 shows the series m*-m relationship of nymph and adult asiatic citrus psyllid in greenhouse. The relationships were expressed as $m^*=3.86+2.83m$ ($r=0.92$) for

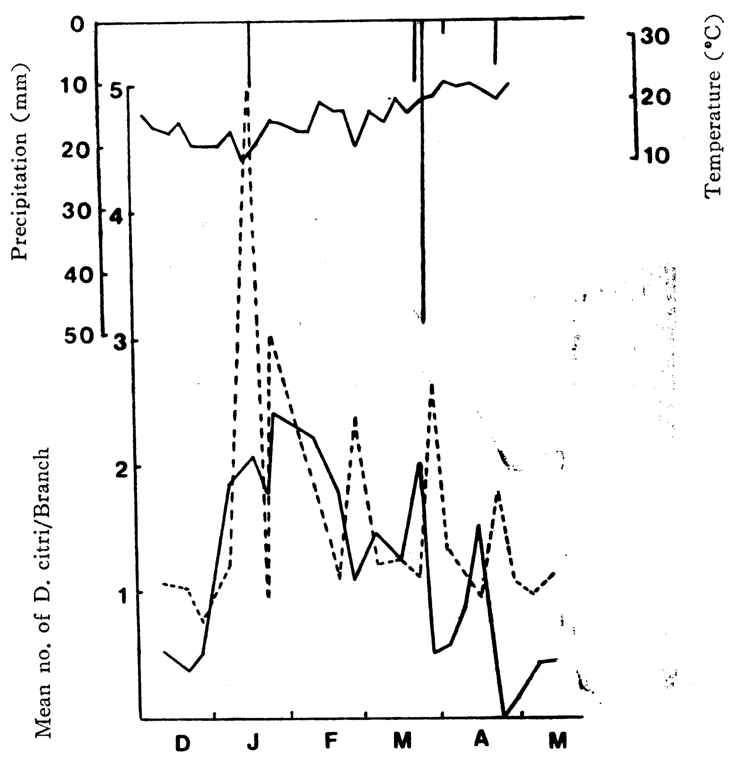


Fig. 4. Population fluctuation of *D. citri* nymph (——) and adult (······) in field.

nymph and $m^*=5.86+1.33m$ ($r=0.92$) for adult. The intercept α, or the index of basic contagion, was lower in the nymphal populations than in the adult populations, i. e., the basic component of the nymphal population was smaller than that of adult. Density contagiousness coeficients, the slope β, expressing the relative degree of aggregation in the distribution of basic components, were larger than 1 in both nymph and adult stages. This indicates the distribution pattern of the basic components of nymphal and adult stages were contagious.

Population density of *D. citri* in natural environment was much lower than that in the greenhouse (Figure 5). The comparatively high densities were only observed during January and February; the time when citrus puts on new leaves. The highest density was 7.5 psyllid per branch on 17 January. Another obvious difference between the field population and the greenhouse population is the frequent fluctuation. The changeble and complicated natural environments made the population of both nymph and adult

fluctuated more violently and frequently in the field.

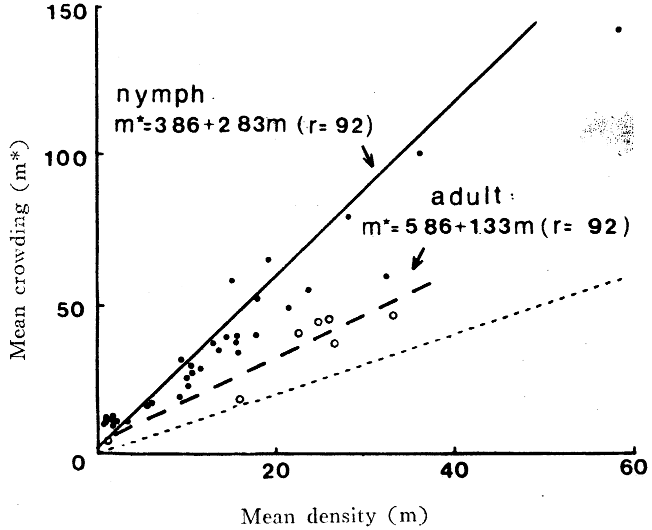


Fig. 5. Series m^*-m relationship of *D. citri* populations in greenhouse. ——with dots : nymph, -------with circular : adult, ···expectation from Poisson series.

Figure 6 shows the series m^*-m relaionship of nymph and adult asiatic citrus psyllid in field. The relationships are expressed as $m^*=0.73+2.46m$ ($r=0.87$) for nymph and $m^*=0.76+2.23m$ ($r=0.74$) for adult. In both cases the intercept α were lower in field than in greenhouse even though the quadrat size sampled were smaller in greenhouse than in field. It indicates the basic components of the psyllid population, no matter at nymph or adult stage, were larger in grenhouse than in field. This might be explained

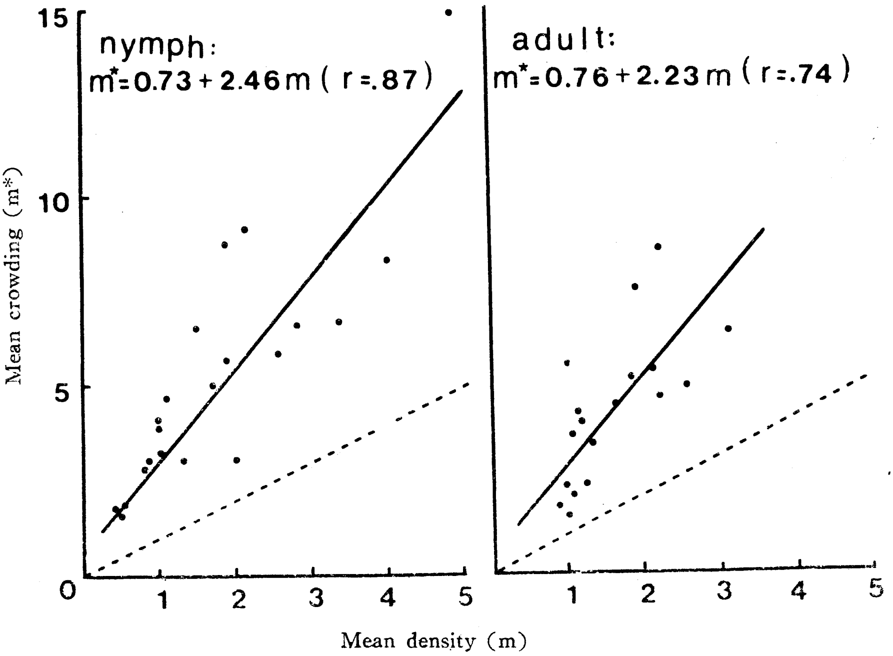


Fig. 6. Series m^*-m relationship of *D. citri* populations in field. Dotted line shows the expectation from Poisson series.

by the larger migration space and higher mortality of this insect in natural environment in the field. β values for populations of both stages in field were fairly close to each other. It seems that the relative degree of contagiousness in field did not vary much with the alternation of the developmental stages. Besides, effect of different environments in greenhouse and in field on the degree of contagiousness were not as significant as that on colony size.

The unit-size relations are shown in Figure 7. It illustrates the change of ρ values with ascending quadrat sizes for asiatic citrus psyllid nymph. It indicated that the nymph aggregated to form colonies with random intra-colony distribution. The colony area ranged from 1 to 4 saplings (1 sapling for 15 populations, 2 saplings for 12 populations, 4 saplings for 2 populations) in greenhouse. Colony area of the nymph in field were from 1 to 2 branches (1 branch for 13 populations and 2 branches for 5 populations).

The aggregation of individuals of naturally existing insects, especially those which lay eggs in clusters, was very common. Ways to observe the characteristics of the aggregated distributions were developed to detect the difference among these popula tions. The m^*/m value and the m^*-m relationship were used in this report to describe *D. citri* population in greenhouse and in field because they were easy to analyze and supplied abundant basic information.

Difference of distributions of populations in these two environments appeared in their methamethical models. Data of all the samples were tested fo fit negative binomial or poisson distributions. Among the 14 populations in field, 5 populations of nymph and 7 populations of adult were fitted well by negative binomial distribution while none of them could be fitted by the poisson distribution. None of the samples obtained in greenhouse could be fitted by either poisson or negative binomial distribution.

Field population of the asiatic citrus psyllid was influenced by food, habitat, rainfall, temperature, aeration, and other unknown factors. These factors having complicated relationships with each other affect the insect population directly or indirectly. With the irregular environmental conditions, the study of the nature of the psyllid population in

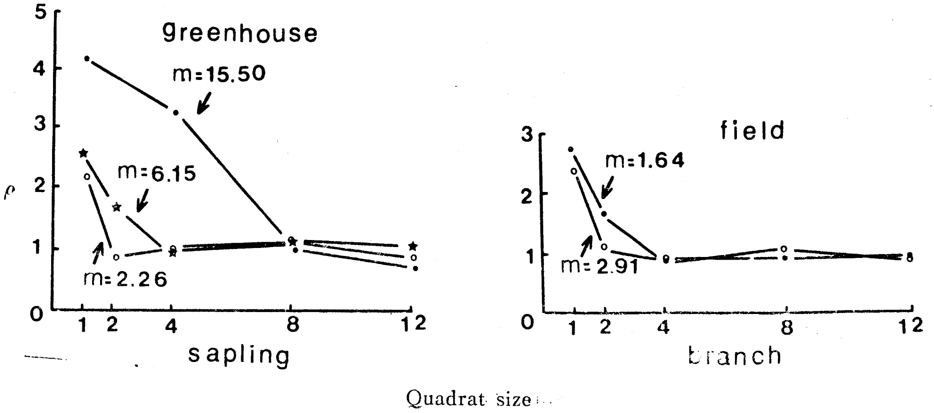


Fig. 7. Examples of ρ indeces of *D. citri* nymph populations in greenhouse and in field plotted against quadrat size.

field is thus difficult. Greenhouse supplies a quite stable environment because many factors which influence the insect population in nature did not exist in the greenhouse. The population fluctuation and spatial distribution in greenhouse is considered the characteristic feature of this insect under a simplified condition.

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References

1. Iwao, S. 1968. A new regression method for analyzing the aggregation pattern of animal populations. Res. Popul. Ecol. 10 : 1-20.
2. Iwao, S. 1972. Application of the m*-m method to the analysis of spatial patterns by changing the quadrat size. Res. Popul. Ecol. 14 : 97-128.
3. Iwao, S. 1977. The m*-m statistics as a comprehensive method for analyzing spatial patterns of biological populations and its application to sampling problems. JIBP Synthesis 17 : 21-46.
4. Lin, S. J., Y. F. Ke, and C. C. Tao. 1973 . Bionomics observation and integrated control of citrus psylla, *Diaphorina citri* Kuwayama. J. Hortic. Soc. China 19 : 234-242.
5. Lloyd, M. 1967. Mean crowding. J. Anim. Ecol. 36 : 1-30.
6. Martinez, A. L. and J. M. Wallace. 1968. Studies on leaf-mottle-yellows disease of citrus in the philippines. Proc. 4th Conf. Int. Org. Citrus Virol. : 167-176.
7. Mead, 1977. The asiatic citrus psyllid, *Diaphorina citri* Kuwayama. (Homoptera : Psyllidae). Entom. Circ. No. 180. Fla. Dept. Agric. & Consumer Serv., Division of Plant Industry.

柑橘木蝨 (*Diaphorina citri* K.) 之生態與空間分布之特性[1]

王清玲[2]

中文摘要

本試驗於民國 68 年冬季至 70 年夏季在臺灣省農業試驗所溫室及田間進行，將 40 隻第 4 或第 5 齡木蝨(*Diaphorina citri* Kuwayama)幼蟲放飼於溫室內 240 株盆栽之酸橘(*Citrus reticulata* var. *Suenket*) 苗上，任其繁衍，所得幼蟲最高密度爲每株 57.1 隻。相對聚集度在木蝨剛開始繁衍密度尚低時很高，其後則隨族羣之增長而降低，經 2 個月後趨於穩定。幼蟲與成蟲之 m*-m 關係可分別以 $m^*=3.86+2.83\ m$ 與 $m^*=5.86+1.33\ m$ 表示，幼蟲與成蟲均聚集成羣落以爲分布之單位，單位內之個體爲逢機分布，單位之間爲聚集性之分布。每一單位所占區域約爲 1 ～ 4 苗木。

田間柑橘園內自然發生木蝨之棲羣密度較溫室爲低，且變化較大，其 m*-m 關係式在幼蟲爲：$m^*=0.73+2.46\ m$, 成蟲：$m^*=0.76+2.23\ m$。幼蟲及成蟲分布之單位均較溫室內者爲小，此二時期之個體在田間分布之聚集性相似，分布單位所占之區域約爲 1 ～ 2 分枝。

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中華農業研究 (Jour. agric. Res. China) 30(4)：420～425 (1981)

膠蟲天敵調查初報[1]

邱瑞珍　周樑鎰　周根清[2]

摘要：本調查自民國67年8月至68年7月先後在臺北、臺中、彰化、南投、嘉義、高雄及屏東等地區採集膠蟲携回室內飼育，共調查得膠蟲寄生性天敵5種，分別爲膠蟲凹胸小蜂 (*Eupelmus tachardiae*)，紫色跳小蜂 (*Tachardiaephagus* sp.)，黃色跳小蜂 (*T. tachardiae*)，紫色釉小蜂 (*Tetrastichus purpureus*) 及介殼蟲小蜂 (*Physcus* sp.) 等，捕食性天敵6種，分別爲草蜻蛉 (*Chrysopa* sp.)，玫瑰紋嚙膠夜蛾 (*Eublemma roseonivea*)，黑點嚙膠夜蛾 (*E. conspersa*)，紅緣瓢蟲 (*Jauravia limbata*)，小黃瓢蟲 (*Scymnus* (*Pullus*) sp.)，中條小黑瓢蟲 (*Telsimia chujoi*) 等；飼育膠蟲時發現捕食膠蟲之草蜻蛉有被草蛉姬蜂 (*Brachycyrtus nawaii*) 與圓腹卵蜂 (*Conostigmus* sp.) 寄生之現象。另有寄主未確定之寄生蜂 38 種。

膠蟲 (*Kerria lacca* (Kerr) (Homoptera：Kerriidae)) 亦稱紫膠介殼蟲，原分布於巴基斯坦、印度、尼泊爾、不丹、中南半島以及我國之南部如廣東、雲南及西藏等省。因其分泌之蟲膠可供木材製品塗料，電氣絕緣體、唱片、染料等工業用品，又可作中藥藥材 (4,11)，實乃一種益蟲。故日人藤井、牧茂市郎、田中長三郎、佐藤致孝、大屋源幸等氏自 1912 年起先後多次從印度與泰國將膠蟲引入臺灣，均遭失敗，最後於 1940 年由高橋良一氏從泰國引入臺灣獲得成功，分別於臺北、臺中、嘉義、臺南及屏東等地進行飼育 (7)。第二次世界大戰後，因合成塑膠化學工業興起，天然蟲膠之工業用途銳減。因此在本省繁殖已歷 40 年之膠蟲，非但未能擴展其工業用途，反而成爲嚴重爲害本省中、南部地區之龍眼、荔枝、釋迦果及榕樹等害蟲。

大滅松 (Dimethoate)、亞素靈 (Azodrin)、福木松 (Anthio) 及撲滅松 (Sumithion) 等藥劑都可有效地防治膠蟲若蟲；而其成蟲因有厚層膠質包蔽，施藥後藥劑不易觸及蟲體，難以收到防治效果 (1,5)，況膠蟲之寄主範圍頗廣，本省已記錄者凡27科 66 種 (2)，我國雲南省亦記錄有 24 科 100 種以上 (11)，如欲全面防治實非易事。尤其山坡地或樹勢高大之果樹施藥更爲困難，因此有效天敵之利用若能與化學防治適當配合，則爲理想之防治對策。

膠蟲之寄生性天敵全世界已記錄者約2目、5 科、15 種，但在印度其寄生蜂之寄生率僅 4.8～9.9％；捕食性天敵至少有4目、12科、22種，但僅以2種嚙膠蛾 *Eublemma amabilis* 與 *Holcocera pulverea* 最屬重要，該蛾等在印度約可造成 35% 之蟲膠損失 (9,13)。廣東省曾從海南島引進 *Bracon greeni* 防治 *E. amabilis*，其寄生率可達 50～70%，雖然每公尺之膠棒 (lac sticks) 仍有 5隻 *E. amabilis* 存在，而蟲膠產量已增加 20～40% (10)。

臺灣產之膠蟲天敵已經記錄者有玫瑰紋嚙膠夜蛾 (*Eublemma roseonivea*)，大避債蛾 (*Clania pryeri*)，圓翅基蛾 (*Holcocera* sp.)，黑刺蟻 (*Polyrhachis dives*)，釉小蜂 (*Tetrastichus purpureus.*)，草蜻蛉 (*Chrysopa* sp.) 以及未定名之螞蟻若干種與爲害荔枝表皮之螟蛾1

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種 [2,3,8]，其中僅以嚙膠夜蛾較爲重要，該蛾曾於 1941 年在嘉義以南地區大量發生捕食膠蟲，以致多處膠蟲全被消滅 [4,8]。又高橋良一於 1940 年因將膠蟲黃色跳小蜂（*Tachardiaephagus tachardiae*）與膠蟲同時引進本省，使引進之膠蟲幾乎全被殲滅。後用孔目 0.5 mm² 之鐵絲網圍住限制其寄生蜂逸出，才使小蜂無法寄生，但屏東與嘉義因處理不徹底此蜂尚未絕跡 [7]。中興大學楊仲圖教授曾 3 次從印度引進 *E. amabilis* 與黃色跳小蜂，惜因印度方面採集困難而又寄遞不當均未成功 [3]。本調查旨在對本省膠蟲天敵作較爲廣泛之蒐集與鑑定。提供膠蟲生物防治研究之基本資料。

材料與方法

民國 67 年 8 月至 68 年 7 月之一年間，筆者等每隔 2 星期分別前往臺北、臺中、彰化、嘉義、臺南

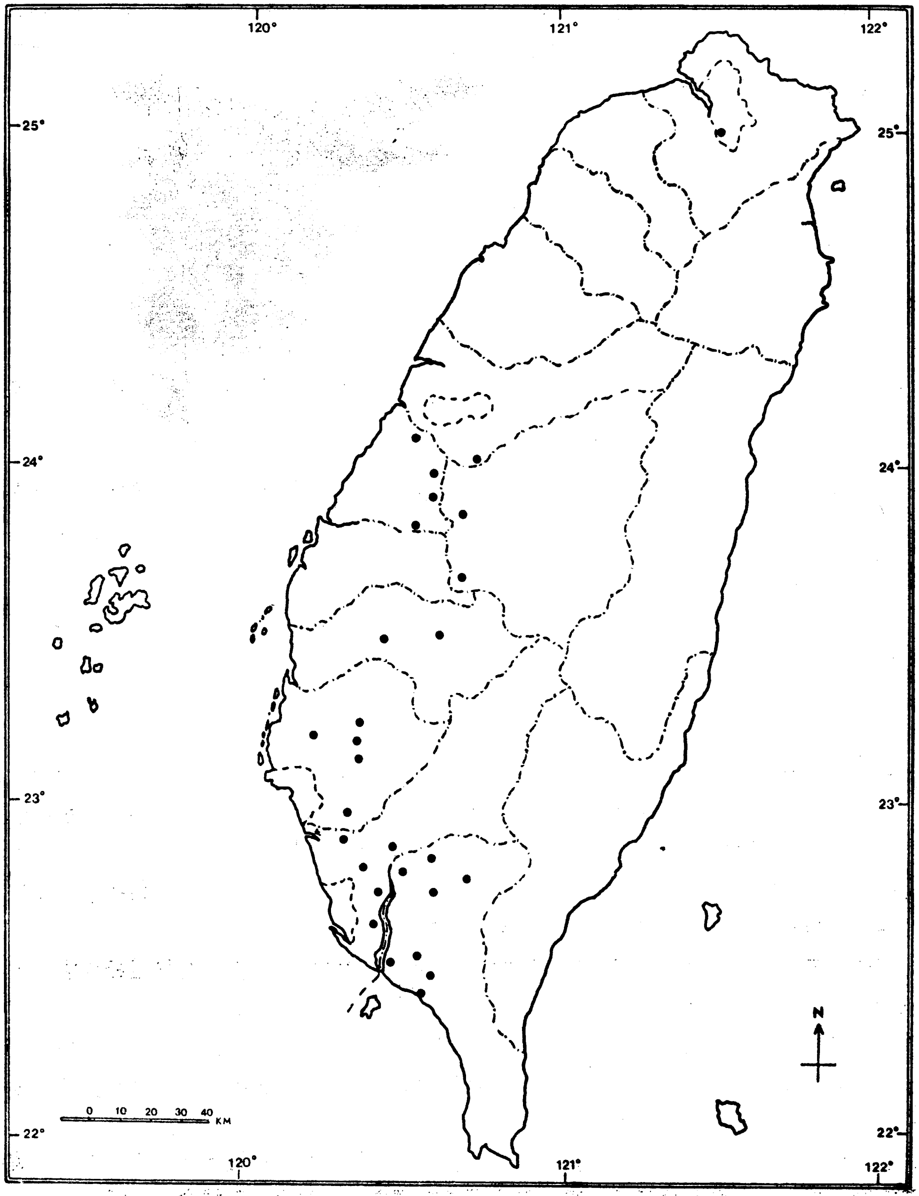

圖 1. 臺灣膠蟲天敵調查地點分布圖

Fig. 1. Map of survey locations on the natural enemies of *Kerria lacca* in Taiwan

、高雄及屏東等地區（圖 1），剪取荔枝，龍眼、釋迦果及榕樹等之膠蟲爲害枝條，即所謂膠棒（lac sticks），帶回試驗室剪成約 15 cm 之小段放入玻璃筒 (9×15 cm) 飼育，筒口蓋以細目尼龍紗布。每日將羽化之寄生或捕食性天敵檢出，分別予以飼育觀察並鑑定種類。

結　　果

臺灣之膠蟲天敵經一年來之採集與飼育，初步鑑定得11種天敵及部分習性未明者，茲分述如下：

膠蟲之寄生性天敵：計採集飼育得寄生性天敵 5 種（表 1），其中以紫色釉小蜂（*Tetrastichus purpureus*）最爲常見，且全年各地均有發生，但該蜂主要寄生於雄性膠蟲；黃色跳小蜂（*T. tachardiae*）僅發現於高雄與屏東地區，出現月份爲 4、5 及 9 至 12 月，但發生量不多；膠蟲凹胸小蜂（*Eupelmus tachardiae*）發現於嘉義以南地區，出現月份爲 6 與 9 至 12 月，發生量亦不多；其他 2 種小蜂僅偶而出現而已。

表 1. 臺灣膠蟲之寄生性天敵

Table 1. Parasitoids of *Kerria lacca* in Taiwan

寄生蜂 Parasitoids	採得地點 Locality recorded
凹胸小蜂科 (Eupelmidae)	
Eupelmus tachardiae	嘉義縣（竹崎），臺南縣（麻豆、關廟、大內、白河），高雄縣（大崗山），屏東縣（三地門）
跳小蜂科 (Encyrtidae)	
Tachardiaephagus sp.	南投縣（名間），臺南縣（官田、關廟），高雄縣（大樹、大崗山），屏東縣（佳冬）
T. tachardiae	高雄縣（大樹、大崗山），屏東縣（鹽埔、佳冬、三地門、新埤、高樹）
釉小蜂科 (Eulophidae)	
Tetrastichus purpureus	全省各採集地點
介殼蟲小蜂科 (Aphelinidae)	
Physcus sp.	彰化縣（員林），嘉義縣（竹崎）

膠蟲之捕食性天敵：計採得捕食性天敵 6 種，分別爲草蛉科 (Chrysopidae) 之草蜻蛉 (*Chrysopa* sp.)；夜蛾科 (Noctuidae) 之玫瑰紋嚙膠夜蛾 (*Eublemma roseonivea*)，黑點嚙膠夜蛾 (*E. conspersa*) 以及瓢蟲科 (Coccinellidae) 之紅緣瓢蟲 (*Jauravia limbata*)，小黃瓢蟲 (*Scymnus* (*Pullus*) sp.) 與中條小黑瓢蟲 (*Telsimia chujoi*)。其中以玫瑰紋嚙膠夜蛾與草蜻蛉較爲常見，但發生量很少，其餘種類亦僅零星出現而已。

膠蟲捕食性天敵之寄生蜂：自膠棒上採得之捕食膠蟲之草蜻蛉，其蛹有被姬蜂科之 *Brachycyrtus nawaii* 與圓腹卵蜂科 (*Ceraphronidae*) 之 *Conostigmus* sp. 寄生。

寄主無法確定之寄生蜂：自膠棒飼育得之一些寄生蜂，其寄主無法確定者共有 14 科，38 種（表 2）。其中可能包括膠蟲之寄生蜂，但絕大多數可能是膠蟲捕食性天敵或雜蟲之寄生蜂，甚至其重複寄生蜂，尚待繼續探明。

本調查尚自膠棒上採得蜚蠊 (*Anaplecta simplex*)、足絲蟻、蠼螋及茶蛀蟲各 1 種，螞蟻若干種，椿象 2 種，蛾類 16 種及甲蟲 18 種。其中混雜有腐食性、植食性及捕食性等類。

表 2. 自膠棒飼育得寄主不明之寄生蜂

Table 2. Parasitoids of unknown relationship with lac sticks

小繭蜂科 (Braconidae)	*Anagyrus sawadai*
Agathis festiva	*Parechthrodyinus* sp.
Apanteles 4 spp.	Unidentified 3 spp.
Leiophron sp.	橫楯小蜂科 (Signiphoridae)
Orgilus sp.	*Rozanoviella* sp.
Protomicroplitis tomentosae	釉小蜂科 (Eulophidae)
大腿小蜂科 (Chalcididae)	nr. *Diglyphomorphella* sp.
Brachymeria sp.	躍小蜂科 (Elasmidae)
Nipponohockeria ishii	*Elasmus* 4 spp.
廣肩小蜂科 (Eurytomidae)	介殼蟲小蜂科 (Aphelinidae)
Eurytoma pallidiscapus	*Coccophagus* sp.
巨胸小蜂科 (Perilampidae)	圓腹卵蜂科 (Ceraphronidae)
Perilampus sp.	*Ceraphron* sp.
黃金小蜂科 (Pteromalidae 6 spp.)	細卵蜂科 (Scelionidae 1 sp.)
凹胸小蜂科 (Eupelmidae)	麥蜂科 (Bethylidae)
Anastatoidea sp.	*Acrepyris* sp.
跳小蜂科 (Encyrtidae)	*Plastanoxus* sp.
Adelencyrtus sp.	*Parasierola* sp.
	Sierola sp.

討　　論

本調查發現在膠棒上活動之昆蟲計有 9 目 85 種以上，其中包括植食性、腐生性、寄生性及捕食性等，種類繁多，而且相互關係複雜。本文僅初步完成膠蟲天敵之種類調查與鑑定，其中若干種類之相互關係，天敵之發生與消長等均有待進一步研究。

本調查所發現之膠蟲寄生蜂以紫色釉小蜂最爲普遍，在本年度調查之地區全年均有發生。惜其主要寄生於雄性膠蟲體內，而雌性膠蟲經由孤雌生殖仍可產生正常性比之後代[8]，因此不能視之爲理想天敵。

黃色跳小蜂曾在 1940 年一度威脅本省膠蟲之繁衍，目前僅在高雄與屏東地區發現，依其過去對膠蟲之抑制記錄，似可將其試行大量繁殖，釋放於其他地區防治膠蟲。

膠蟲凹胸小蜂除寄生膠蟲外，亦寄生於膠蟲之捕食性天敵[13]，因此該蜂在本省之寄主種類亦需進一步加以瞭解。

1941 年曾大量發生之玫瑰紋嚙膠夜蛾在本調查中很少發現，其原因可能由於受多種寄生蜂所抑制，故其寄生蜂種類亦應探明。

就本年度之初步調查，顯示膠蟲之本省天敵在目前之生態環境下，似乎無法抑制膠蟲族羣之發生，將來實有必要自印度或泰國引進其有效天敵。例如在印度、泰國及我國大陸南部地區之膠蟲，其重要之捕食性天敵是嚙膠夜蛾 *E. amabilis*。但其本身之寄生性天敵至少有13種[12]，若能將其引進本省而嚴防其寄生性天敵之帶入，則頗值一試。

Malhotra 與 Katiyar 報導外米綴蛾 (*Corcyra cephalonica*) 之食性包括有蟲膠、活或死的

膠蟲以及膠蟲寄主植物樹皮[12]。其食性包括植食性、捕食性及腐食性等。依此推測與膠棒相結合之許多種昆蟲亦可能有此類似之食性。

誌謝：本調查承前中國農村復興聯合委員會補助部分經費（79-ARDP-1.3-A-399），國立中興大學楊仲圖教授鑑定瓢蟲學名，本系林珪瑞先生鑑定小蜂總科昆蟲學名，謹此誌謝。

參 考 文 獻

1. 李新傳・1966・臺灣南部膠蟲之研究。臺灣農業 2(4):124-144。
2. 黃振聲、謝豐國・1981・果樹膠蟲發生、生活史及形性研究。中華植保會刊 23(2)：103-115。
3. 楊仲圖・1978・膠蟲天敵之研究。科技研究摘要：380。國科會科技中心編。
4. 鄭鳳瀛・1948・臺灣膠蟲一年之飼育經過。農報 2(1):45-54。
5. 謝豐國、黃振聲・1981・果樹膠蟲藥劑防治試驗。中華植保會刊 23(1):25-33。
6. 牧茂市郎・1915・ラツクに就きて。臺灣農事報 9(109):1353-1362。
7. 高橋良一・1942・ラツク介殼蟲の臺灣への輸入。臺灣農事報 38:685-692。
8. 高橋良一。1942・臺灣に於けるラツク介殼蟲の飼育試驗。臺灣農事報 38:755-769。
9. Glover, P. M. 1937. Lac cultivation in India. Indian Lac Res. Inst., Namkum, Ranchi. 147 pp.
10. Kwangtung Inst. Ent. 1975. Experiments to control *Eublemma amabilis* Moore by liberating *Bracon greeni* Ashmead in the forests of lac production. Acta Ent. Sinica 18(2):141-150. (RAE(A) 64 : 566).
11. Liu, C. L. 1957. The lac insect in China. Indian J. Ent. 19(2):85-90.
12. Malhotra, C. P. & R. N. Katiyar. 1970. *Corcyra cephalonica* Stainton, a new predator of lac insect, *Kerria lacca* (Kerr) in the laboratory culture. Indian J. Ent. 32:104.
13. Varshney, R. K. 1976. A check-list of insect parasities associated with lac. Orient. Ins. 10 (1) : 55-78.

A preliminary survey on the natural enemies of *Kerria lacca* (Kerr) in Taiwan[1]

Shui-chen Chiu, Liang-yih Chou and Ken-ching Chou[2]

Summary

The lac insect, *Kerria lacca* (Kerr) (Kerriidae, Homoptera), is now considered as a serious pest of the fruit trees, longan, litchi and sugar apple, and *Ficus* spp. in Taiwan. A general survey of the natural enemies of *Kerria lacca* (Kerr) was conducted in Taipei, Taichung, Changhua, Nantou, Chiayi, Tainan, Kaohsiung and Pingtung from August 1978 until July 1979. A total of 5 parasitoids, *Eupelmus tachardiae* (Eupelmidae), *Tachardiaephagus* sp., *T. tachardiae* (Encyrtidae), *Tetrastichus purpureus* (Eulophidae) and *Physcus* sp. (Aphelinidae); and 6 predators, *Chrysopa* sp. (Chrysopidae), *Eublemma roseonivea*, *E. conspersa* (Noctuidae), *Jauravia limbata*, *Telsimia chujoi*,

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Scymnus (*Pullus*) sp. (Coccinellidae) were found. Two parasitoids, *Brachycyrtus nawaii* (Ichneumonidae) and *Conostigmus* sp. (Ceraphronidae) were reared from the predator, *Chrysopa* sp. of *K. lacca*. Besides, 38 hymenopterous parasitoids associated with the lac sticks are still unknown to the authors. It is apparently that further studies on the natural enemies of the lac insect are still needed.

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Genera of the Trichogrammatidae (Hymenoptera : Chalcidoidea) of Taiwan with descriptions of new taxa

K. S. Lin[2]

Abstract : This paper is based upon the examination of about 7,000 slide specimens of trichogrammatids which were mostly collected by sweep net in Taiwan. It consist of 22 genera. Of these, only *Paracentrobia* Hwd., *Trichogrammatoidea* Grlt., *Trichogramma* West. and *Oligosita* Wlk. have been previously known to this island, whereas *Ufens* Grlt., *Poropoea* Frst., *Ophioneurus* Rtbg., *Lathromeroidea* Grlt., *Lathromeris* Frst., *Hispidophila* Vigg., *Haeckeliania* Grlt., *Chaetostricha* Wlk., *Uscana* Grlt., *Latheromeromyia* Grlt., *Giraultiola* Nwk., *Probrachista* Vigg., *Aphelinoidea* Grlt., *Epoligosita* Grlt. and *Megaphragma* Tblk. are hereby recorded for the first time, and *Prochaetostricha monticola* and *Eutrichogramma elongatum*, genn. et spp. nov. are described and illustrated. A key is given for the separation of the genera of Taiwan.

The small to minute members of the family Trichogrammatidae, Hymenoptera, are widespread, abundant, and reflects their mode of development as internal parasites of various insect eggs, mostly of Lepidoptera or Homoptera, and to a less extent of some other orders. The minuter adults of *Megaphragma* may measure no more than 0.18 mm. in total length these are probably the smallest of all insects for they develop within the eggs of thrips. Some of trichogrammatids are interesting in habit which has adopted an aquatic habitat. Of these, parasitizes the eggs of aquatic insects mainly those of water beetles, water bugs or dragonflies. They can swim in and on the surface of water with their legs, which are long and slender fringed with long hairs.

The trichogrammatid wasps, especially the genus *Trichogramma* has been used for biological control of various farm, vegetable and forest pests, mostly of the Lepidoptera, in different countries of the World.

The Trichogrammatidae of Taiwan have hitherto been little studied, the previous authors as Ishii (1941), Sonan (1944), Lin (1974) and Nagaraja (1978) recorded *Trichogramma australicum*, *T. chilonis*, *T. dendrolimi*, *T. japonicum*, *Trichogrammatoidea bactrae*,

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T. nana, *Paracentrobia andoi* and *Oligosita* spp. from this island.

The specimens of Trichogrammatidae in this study are more than 7,000 slides which were mostly collected by the author use of sweeping net on the weeds or secondary forest. Twenty-two genera are discorvered as 4 of the known genera and 16 the first records. Two new genera and species are described. All specimens are deposited in the Insect Collection of the Taiwan Agricultural Research Institute, Taichung.

List of genera

(Those marked with an asterisk are new records for Taiwan)

1. **Ufens* Girault
2. **Mirufens* Girault
3. **Poropoea* Förster
4. **Ophioneurus* Ratzeburg
5. **Lathromeroidea* Girault
6. **Lathromeris* Förster
7. **Hispidophila* Viggiani
8. **Haeckeliania* Girault
9. **Prochaetostricha* gen. nov.
10. **Chaetostricha* Walker
11. *Paracentrobia* Howard
12. **Uscana* Girault
13. **Lathromeromyia* Girault
14. **Giraultiola* Nowicki
15. *Trichogramatoidea* Girault
16. *Trichogramma* Westwood
17. **Probrachista* Viggiani
18. **Eutrichogramma* gen. nov.
19. **Aphelinoidea* Girault
20. *Oligosita* Walker
21. **Epoligosita* Girault
22. **Megaphragma* Timberlake

Tentative key to genera of Trichogrammatidae in Taiwan

1. Body dorso-ventrally flattened, abdomen very broad ; forewing narrow, peculiarly shaped as a flattened sigmoid, marginal fringe very long ; body size unusually small, ranging in length of 0.15-0.25 mm. .... *Megaphragma* Timberlake, 1923
- Body not dorso-ventrally flattened ; forewing not extraordinarily narrow nor shaped as a flattened sigmoid........ 2
2. Female club 5-segmented ; antenna without a funicle 3
- Female club of less than 5 segments, funicle present or absent........ 7
3. Antennal club with large, forward-curving spines, some of them are branched........ *Haeckeliania* Girault, 1913
- Antennal club without large, branched and forward-curving spines 4
4. Antennal scape impressed to receive the large, globular and spinose pedicle ; basal 4 segments of club fused into a large hemispherical structure bearing stout spines from which the apical club segment is produced as a cylindrical projection bearing several long setae .... *Hispidophila* Viggiani, 1968
- Antennal segments not so peculiarly formed, normal, the club more or less spindle-shaped with distinct and transversely divided segments........ 5
5. Vein track RS_1 absent ; club with an apical process........ *Lathromeris* Förster, 1856
- Vein track RS_1 present ; club without an apical process........ 6
6. Maxillary palpus of single segment ; forewing elongate, rounded distally ; marginal vein much longer than stigmal vein ; vein tracks conspicuously converging near apex of retinaculum. .... *Lathromeroidea* Girault, 1912
- Maxillary palpus 2-segmented ; forewing very broad, oblately rounded distally ; marginal vein as long as stigmal vein ; vein tracks not conspicuously converging near apex of retinaculum .... *Ophioneurus* Ratzeburg, 1852

7. Marginal vein of female failing to touch anterior border of forewing, or the costal cell extraordinarily elongated and extending distally at least one-half the total length of the wing blade ·········· *Poropoea* Förster, 1851
- Marginal vein of female coinciding with anterior border of forewing ·········· 8
8. Forewing disc with the microtrichiae beyond venation short, abundant and dense, randomly distributed or seldom arranged in lines; the abundance of these discal cilia on forewing resembles that usually seen in other families of Chalcidoidea ·········· 9
- Forewing disc without such an abundance of short, dense microtrichiae; instead discal cilia may be sparse, nearly lacking, or if present then usually arranged in lines or with several complete vein tracks; if not arranged in lines then the discal cilia are not so abundant, dense and short ·········· 10
9. Funicle 2-segmented, cylindrical and distinctly separated, club of 2 segments not broadly joined; ovipositor distinctly exserted·········· *Probrachista* Viggiani, 1968
- Funicle absent; club of 2 segments broadly joined·········· *Aphelinoidea* Girault, 1911
10. Female club with single segment, funicle with 2 segments ··········11
- Female club with more than 1 segment ··········12
11. Vein track RS_1 present, male club with single segment ··········*Trichogramma* Westwood, 1833
- Vein track RS_1 absent; male club with 3 segments·········· *Trichogrammatoidea* Girault, 1911
12. Funicle with 1 segment ··········13
- Funicle absent, or 2-segmented··········14
13. Antennal club 3-segmented; forewing elongate, discal cilia sparse or near lacking; marginal vein long, straight, much longer than stigmal vein·········· *Oligosita* Walker, 1851
- Antennal club 1- or 2-segmented; fore wing somewhat ovoid, pointed apically, discal cilia entirely devoid·········· *Epoligosita* Girault, 1916
14. Funicle absent, female club 2- or 4-segmented ··········15
- Funicle present or absent, female club 3-segmented (sometime 4-segmented in male) ··········18
15. Club 2-segmented; second segment slender; maxillary palpus 2-segmented ·········· ·········· *Eutrichogramma* gen. nov.
- Club 4-segmented; maxillary palpus only 1 segment ··········16
16. Vein track of RS_1 absent, marginal vein of forewing long, straight, marginal fringe long ··········17
- Vein track of RS_1 present, marginal vein of forewing and marginal fringe short·········· ·········· *Uscana* Girault, 1911
17. Forewing shaped as in subgenus *Zorontogramma* of *Oligosita*, never broad at apex·········· ·········· *Lathromeromyia* Grault, 1914
- Forewing rounded and broadened at apex··········*Giraultiola* Nowicki, 1936
18. Valvifers very elongated within abdomen, often penetrating deeply into thorax; ovipositor very long, frequently very greatly exserted··········19
- Valvifers not so elongated within abdomen, normal; ovipositor not so extraordinarily developed ··········20
19. Maxillary palpus of 2 segments, first funicle nearly trapezoid, slightly smaller and distinctly separated from the second; marginal vein of forewing rather short, vein track RS_1 absent, marginal fringe long. ·········· *Prochaetostricha* gen. nov.
- Maxillary palpus of 1 segment; first funicle segment small, scale-like, broadly joined, second funicle long, cylindrical; marginal vein of forewing long, vein track RS_1 present, marginal fringe short·········· *Chaetostricha* Walker, 1851
20. Forewing elongated, rounded distally; discal cilia abundant or sometime arranging on several

vein tracks, vein track RS_1 may or may not be present, base of premarginal vein smooth, narginal vein long, straight .... *Paracentrobia* Howard, 1897
– Forewing broadly oblate distally, discal cilia distinctly arranging on vein track, basal vein track and radial process conspicuously present 21
21. Maxillary palpus of 2 segments ; each funicle segment longer than wide, cylindrical, distinctly separated .... *Mirufens* Grault, 1915
– Maxillary palpus of 1 segment ; first funicle shorter and broadly joined to the second, ... *Ufens* Girault, 1911

Genus *Ufens* Girault

Ufens Girault, 1911. Trans. Amer. Ent. Soc. 37 : 32-35. Type-species : *Trichogramma nigrum* Ashmead. Original designation. Centralia, Illinois.
Ufensia Girault, 1913. Mem. Queensl. Mus. 2 : 101. Type-species : *Ufensia pretiosa* Girault. Original designation. (Redescribed as new genus by Girault, with same genotype, in Proc. Ent. Soc. Wash. 16 : 118, 1914)
Neocentrobia Blood, 1923. Ann. Rept. Proc. Bristol Nat. Soc. 2 : 101. Nom. nud.
Neocentrobia Blood and Kryger, 1928. Ent. Meddel. 16 : 203. Preocc. by Girault, 1912. Type-species : *Neocentrobia hirticornis* Blood and Kryger. Original designation.
Stephanotheisa Soika, 1931. Natuurh. Maandbl. 20 : 111. Type-species : *Stephanotheisa vitoldi* Soika. Monotypic.
Grantanna Girault, 1939. Ohio Jour. Sci. 39 : 324. New name for *Neocentrobia* Blood and Kryg nec Girault.

Ufens is a large and worldwide distributed genus. The characteristic structures of this genus by the presence of the forewing very broad oblate and nearly truncate apically, marginal fringe are very short, marginal vein short, stigmal vein is as long as the marginal vein, with very distinct vein tracks. Female antenna has 2 small annelli, the 2 funicle segments are obliquely divided but with junction confused, club 3-segmented. Male antennal club 4-segmented with whorls of curved bristles, terminal segment is very small.

Two undescried species have been discovered in Taiwan.

Genus *Mirufens* Girault

Mirufens Girault, 1915. Mem. Queensl. Mus. 3 : 147. Type-species : *Mirufens dentipes* Girault. Original designation. Queensland.
Trachocera Blood and Kryger, 1928. Ent. Medd. 16 : 208-209. Type-species : *Asynacta longicauda* Blood, 1923=*Trachocera longicauda* Blood and Kryger, 1928.

Mirufens is a small genus and distributed in Queensland, Sri Lanka, Syria and Europe. Three species have been described. Doutt and Viggiani (1968) divided into 2 subgenera. In the subgenus *Mirufens* (s. s.) marginal vein of female fails to attain the anterior border of forewing, and a distinct break between the premarginal and marginal veins. The stigmal vein much longer than either premarginal or marginal vein. The subgenus *Mirufens* (s. s.) in known from Queensland and Sri Lanka. The specimens known of subgenus *M.* (*Trachocera*) are from Europe and Syria. They are separated from the subgenus *Mirufens* (s. s.) by the marginal vein touches the border of forewing, and by the more elongate club and funicle segments. The female antenna has a distinctly ridged pedicel, 2 annelli, 2 distinctly quadrate and

articulate funicle, and long pointed 3-segmented club. The male antenna is quite different with long forward-curving bristles arranged in whorls on the flagellar segments.

Only one undescribed species has discovered as a parasite of the eggs of *Chunvocerus niveosparsus*, Cicadellidae, which attacked the Mango trees in Taiwan.

Genus *Poropoea* Förster

Poropoea Förster, 1851. Verh. naturh. Ver. preuss. Rheinl. 8 : 28. Type-species : *Poropoea stollwerckii* Förster. Monotypic. Germany.

Poropoeoides Nowicki, 1936. Zeit. angew. Ent. 23 : 125-26. Type-species : *Poropoeoides bohemica* Nowicki. Original designation. Poland.

Poropoea widely distributed in Europe, Poland, Italy, India, Sumatra, Japan and U. S. A. Nine species have been described, they are the egg parasites of attelabid beetles. The characteristic structures of this genus in having the body stout and strongly convex, ovipositor very long, and the strongly sigmoid venation which fails to attain the anterior margin of forewing. The female antenna has 2 large, cylindrical, and articulated funicle segments with a tapering, 3-segmented club. The male has the same segmentation in the club but with segments less stout.

Only one undescribed species has been discovered in Taiwan.

Genus *Ophioneurus* Ratzeburg

Ophioneurus Ratzeburg, 1852. Ichneumo der Forstinsekten 3 : 196. Type-species : *Ophioneurus signatus* Ratzeburg. Designated by Gahan and Fagan, 1923. Germany.

Mooa Girault, 1930. New Pests from Australia 7 : 2. (Privately published). Type-species : *Mooa nigrivena* Girault. Original designation.

Ophioneurus is a rather small genus which distributed in Europe and Queensland. There are 4 species have been described. Its structures is characteristic by the presence of greatly widened and oblate apex of forewing with short venation, marginal vein shorter than premarginal vein, stigmal vein broad; wing disc with cilia marked the important vein tracks. Maxillary palpus with 2 segments ; antennal club with 5 segments and sharply pointed apically, funicle absent.

Only one undescribed species has been discovered in Taiwan.

Genus *Lathromeroidea* Girault

Lathromeroidea Girault, 1912. Mem. Queensl. Mus. 1 : 94. Type-species : *Lathromeroidea nigra* Girault. Original designation. Herberton, North Queensland.

Centrobiopsis Girault, 1918. North Amer. Hym. Trichogrammatidae: 4, 7. (Privately published). Type-species : *Centrobia odonatae* Ashmead. Original designation.

This genus distributed in Queensland, Brazil, Eastern United States of America and Poland. Five species have been described. Its structures is characteristic by the presence of an unusual and conspicuous convergence of the base of vein tracks RS_1, M, Cu and A. Forewing is long and moderately wide, with narrow base and round apex. Antenna with 2 annelli and lacking funicle, club 5 segments, with forward curving spines and both pedunculate and elongate sensoria.

Only one undescribed species of this genus has been discovered. It was found rather abundant on the grass and parasitized the eggs of *Nephotettix cincticeps*, Cicadellidae, which attacked the rice plant in Taiwan.

Genus ***Lathromeris*** Förster

Lathromeris Förster, 1856. Hymenopterologische Studen 2 : 82. Type-species : *Lathromeris scutellaris* Förster. Original designation. Germany.

Lathromerella Girault, 1912. Mem. Queensl. Mus. 1 : 93. Type-species : *Lathromerella fasciata* Girault. Original designation.

Garouella Risbec, 1956. Bull. Inst. Fr. Afr. Noire, A 18 : 818. Type-species : *Garouella ovicida* Risbec. Original designation.

Lathromeris is a large genus and widely distributed in Europe, Africa, Australia, South America and North America. It is characteristic by the presence of a 2 small annelli which the second is scale-like and appressed to the first, lacking funicle segment, the club large, with 5 segments, the basal segment rather small of which may resemble a funicle segment, apical club segment frequently terminates in a rod-like spicula. The marginal vein of forewing is long and the vein track RS_1 is absent.

One undescribed species has been discovered in Taiwan.

Genus ***Hispidophila*** Viggiani

Hispidophila Viggiani, 1968. Proc. Calif. Acad. Sci. 4 ser. 35(20) : 503. Type-species : *Haeckeliania brontispae* Ferriere. Original designation. Java, South Celebes.

Hispidophila distributes in Java, South Celebes and Malaya. Only the type species has been reported parasitizing into the eggs of hispid beetles, Chrysomalidae, which fed upon the foliage of coconuts. The characters of this genus by the presence of the maxillary palpus 1 segment, antenna with short scape, its lower surface depressed formed a wide concavity which receive the large pedicel, the 2 annelli are small, club with 5 segments, the basal 4 segments broadly, obliquely fused each other and formed a large globosity, the apical segment elongate and pointed apically. Forewing long, rounded apically, marginal vein long and with a cluste thick setae, stigmal vein long, the slightly distinct vein tracks are a distinictive features.

Only one undescribed species has been discovered in Taiwan.

Genus ***Haeckeliania*** Girault

Haeckeliania Girault, 1912. Mem. Queensl. Mus. 1 : 97-98. Type-species : *Haeckeliania haeckeli* Girault. Original designation. Herberton, North Queensland.

Haeckeliania is merely distributed in Queensland and 4 species have been described. The characters of *Haeckelinania* by the presence of the small and stout body. Maxillary palpus with 2 segments ; antenna with 2 annelli, funicle segment absent, club with a particularly complex 5-segmented, and bering large, gross, forward-curving spines that may be branched. Forewing moderately broad, marginal vein slightly shorter than premarginal, vein track RS_1 converging with the anterior portion of vein track Cu.

Only one undescribed species has been found in Taiwan.

Genus ***Prochaetostricha*** Lin, gen. nov.

Type-species : *Prochaetostricha monticola* Lin, sp. nov. Present designation.

Body stout. Head normal, genal suture lacking, maxillary palpus 2-segmented; antennal formula with a single rather large annellus which dorsal surface with a seta, and 2 distinctly separated funicle; female with 3-segmented club, rather abundant cilia and linear sensoria, second and third segments are incompletely separated, third segment with an apical projection; male antenna with long and sparse bristles, 4-segmented club and very small apical segment. Forewing broad, rounded distally, marginal fringe long, marginal vein shorter than either premarginal or stigmal veins, disc with sparse cilia, vein track distinct except RS_1 absent. Valvifers very elongated within abdomen and penetrating deeply in thorax, ovipositor sheath exserted, very long and upcurved.

Prochaetostricha is characteristic by the forewing, antennal formula and the long ovipositor those are easily distinguished from *Chaetostricha* Walker in the previous key.

Prochaetostricha monticola Lin, sp. nov.

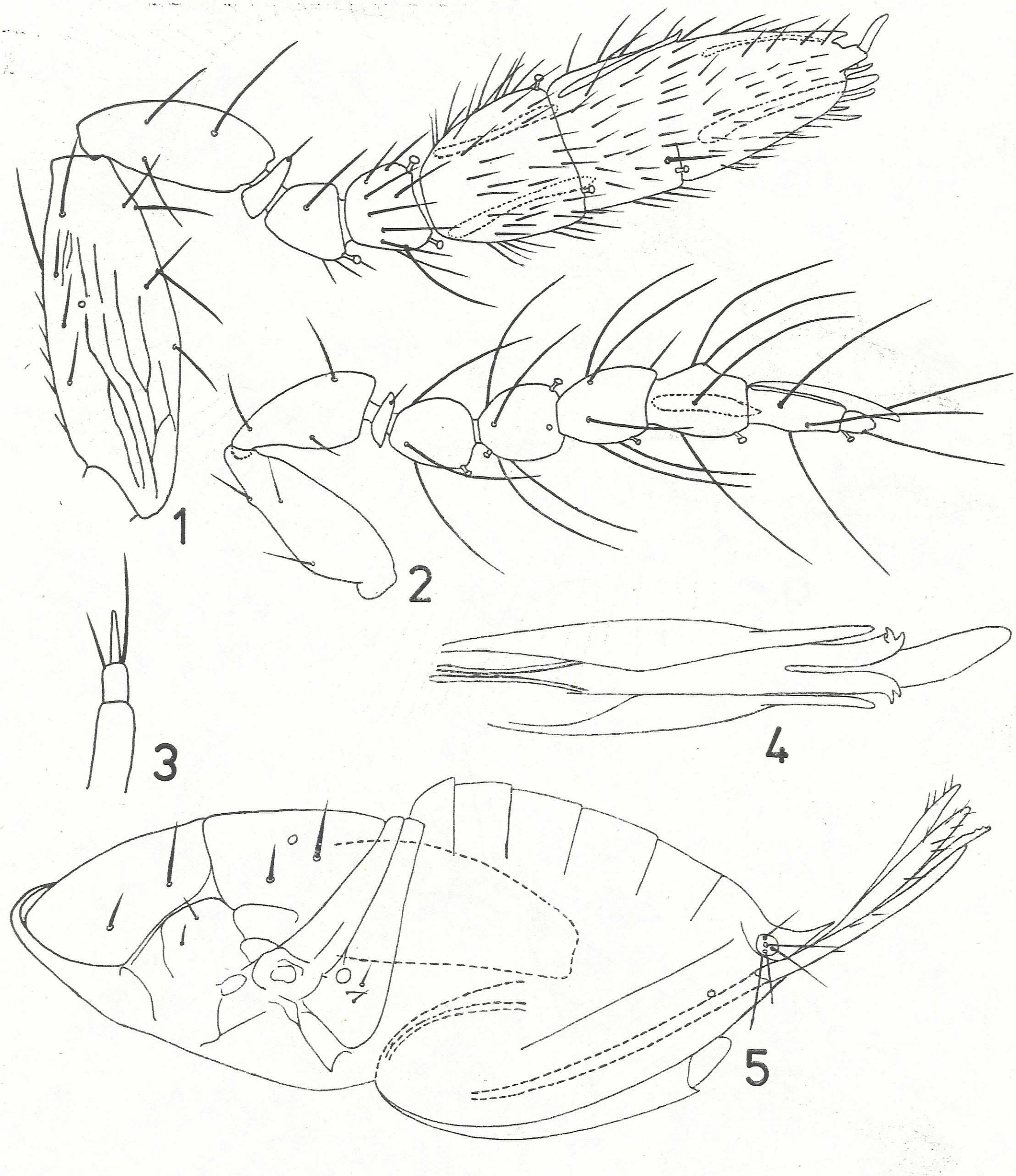
(Figs. 1-7)

Female. Brownish-black, eyes reddish, antennal club I and apical portion of tibia lighter ; wing hyaline, basal 1/2 of forewing infuscate, venation brownish, apex of premarginal vein lighter; submarginal vein, radial process, beneath of premarginal, marginal veins and pterostigma slightly darker.

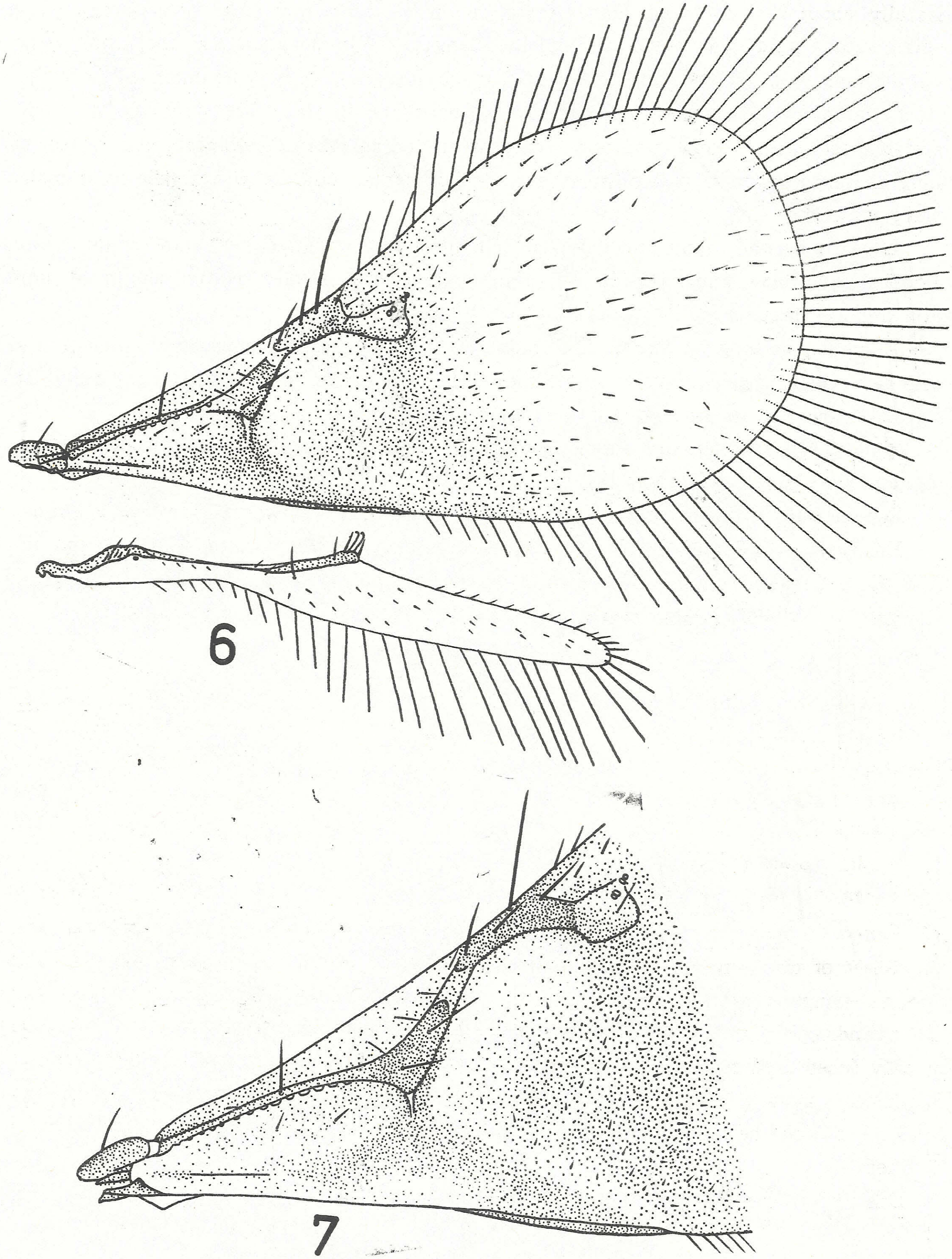
Body stout. Head suboblated, shorter than wide (0.8x) in frontal view; eyes moderately large, with sparse cilia; lateral ocellus lying close to eye and its interspace as long as ocellus diameter; malar space 1/3 as long as high of eye and genal suture absent; mandible with 3 very sharped outer teeth, the inner one broad and truncate apically ; maxillary palpus 2-segmented, basal one broad and about 4.6x as long as the segment II, segment II narrow; labial palpus 1-segmented, similar to the segment II of maxillary palpus; antenna inserted at under level of lower margin of eye; scape reaching to median ocellus, laterally compressed, 2.8x as long as wide, with setae and longitudinal, irregular sculptures; pedicel 0.4x as long as scape; annellus only 1 segment, rather large, with 1 dorsal seta; funicle with 2 separated segments, funicle II distinctly larger than I and with setae lying on 2 section; club with 3 segments but segment II and III not completely separated, distinctly longer and wider than scape, with abundant cilia, I, II and III segments with 2, 1 and 2 linear sensoria respectively, segment III with an apical process.

Pronotum short and declivous anteriorly; mesoscutum moderately convex, scutellum weakly convex, both with longitudinal irregularly reticulated sculptures and each with 2 setae laterally ; relative length of mesoscutum, scutellum, metanotum and propodeum about 18, 13.5, 1 and 2.5 ; spiracle of propodeum rounded, with 3 cilia on spiracle behind; mesopostphragma reaching to half of abdomen.

Forewing about 1.6 longer than wide and rounded apically, with venation extending



Figs. 1–5. *Prochaetostricha monticola* gen. et sp. nov. 1, antenna of female ; 2, antenna of male ; 3, maxillary palpus ; 4, male genitalia ; 5, body in lateral view.



Figs. 6–7. *Prochaetostricha monticola* gen. et sp. nov. 6, wings of male; 7, basal half of forewing, female.

distally about 0.53 of wing blade; costal cell wide and with 3 cilia near premarginal vein; submarginal vein equal to combined length of premarginal and marginal veins, with 1 long seta at its midlength; base of premarginal vein wider than apex, with 2 cilia ; radial process present ; marginal vein distinctly shorter than premarginal vein, straight and with 1 long seta and 3 cilia on its dorsal surface; stigmal vein broad, as long as marginal vein, pterostigma large, subquatrate; cilia on wing blade as in male ; marginal fringe long.

Legs moderately long and hairy, with longitudinal irregular reticulate sculptures on femora and tibiae, and irregular reticulate sculptures on coxae; relative length of hind tiba and its tarsus about 26, 7, 6, 6.

Abdomen as long as thorax and more or less laterally compressed, smooth and with few cilia, valfifers very elongated within abdomen and penetrating deeply in thorax; ovipositor sheath exserted, very long and upcurved.

Male. Similar to female; antenna with long setae as Fig. 2, club 4-segmented, apical segment very small; wings as Fig. 6, pterostigma subtriangular.

Female body 1.5 mm., forewing 1.5 mm. ; male body 0.85 mm., forewing 1.1 mm.

Holotype. ♀ (#14530) TAIWAN Central, Meifeng, 2,150m, Nantou Hsien, 20-22. VI. 1979, K. S. Lin and B. H. Chen (both of forewings apically and hindwing are distorted) Allotype. ♂ (#14520) same locality but collected on 18. VII. 1979, K. C. Chou.

Genus ***Chaetostricha*** Walker

Chaetostricha Walker, 1851. Ann. Mag. Nat. Hist. (2) 7 : 211. Type-species : *Chaetostricha dimidiata* Walker. Monotypic. Holywood, North Ireland.

Centrobia Förster, 1856. Hymenopterologische Studien 2 : 87. Type-species : *Calleptiles walkeri* Förster. Original designation.

Centrobiella Girault, 1912. Mem. Queensl. Mus. 1 : 90. Type-species : *Centrobiella mulierum* Girault. Original designation.

Ratzeburgalla Girault, 1938. Rev. Ent. Rio de Janeriro 8 : 80.

Chaetostricha is a large genus and worldwide distributed. The characteristic structures of this genus is by the presence of 2 small annelli, 2 funicle segments and with an elongate tapeing 3-segmented club, the second segment of funicle is very long and cylindrical, much longer than the first one, first segment somewhat scale-like and broadly fused with the second segment. Forewing rounded distally with marginal fringe moderately short, marginal vein long and straight, stigmal vein usually distinctly constricted, and the vein tracks conspicuously completed. Ovipositor long and usually exserted.

One undescribed species has been discovered in Taiwan. It occurred rather abundant on the weeds.

Genus ***Paracentrobia*** Howard

Paracentrobia Howard, 1897. Jour. Linn. Soc. London Zool. 26 : 178. Type-species : *Paracentrobia punctata* Howard. Monotypic. Grenada, West Indies.

Abbella Girault, 1911. Trans. Amer. Ent. Soc. 37 : 9-11. Type-species : *Abbella subflava* Girault.

Original designation.

Jassidophthora Perkins, 1912. Bull. Expt. Stn. Hawaiian Sugar Planters' Assoc., Ent. Ser., 10 : 17. Type-species : *Jassidophthora prima* Perkins. Monotypic.

Abbellisca Ghesquiere, 1946. Rev. Zool. Bot. Afr. 39 : 371. New name for *Abbella* Girault nec Heyden.

This genus is a large, abundant and cosmopolitan. Antnnal annellus with 2 segments, funicle with 2 segments which are distinctly separated or broadly joined, club elongate, with 3 segments. Forewing long and rounded distally, with moderately short marginal fringe, wing blade with abundant discal cilia or with distinct vein tracks. Doutt and Viggiani (1968) divided this genus into 3 subgenus : The subgenus *Ittys* has 2 funicle elongate and distinctly separated those are different from the 2 other subgenus, and the wing disc with distinct vein tracks. The subgenus *Brachistella* having forewing disc covered with short, randomly distributed cilia, without complete and distinct vein tracks; and the forewing of the subgenus *Paracentrobia* (s. s.) having somewhat sparse cilia more or less arranged in a few lines, substigmal spot usually present.

There are 4 species of the genus have been discovered in Taiwan. *P.* (*Brachistella*) *andoi* is common, abundant in summer and autumn which are parasitized into the eggs of the rice leaf hopper, *Nephotettix cincticeps* or the other cicadellids on the grass. Another 3 species of the subgenus *Paracentrobia* (s. s.) are not as common as *P. andoi.*

Genus *Uscana* Girault

Uscana Girault, 1911. Trans. Amer. Ent. Soc. 37 : 22-23. Type-species : *Uscana semifumipennis* Girault, Origiaal designation. Beeville, Texas.

Bruchoctonus Grese, 1923. Bull. Saratov Seed Select Admin. Sugar Trust, Kiev, 7 : 117. Type-species : *Bruchoctonus senex* Grese.

Uscana is a large, worldwide genus. The characteristic structures of this genus by the antenna with 4-segmented club in both sexes bears long setae and both pedunculate and linear sensoria, funicle segment absent. Forewing broadly rounded distally, under the venation infuscate, marginal vein straight and slightly short, vein tracks distinct, marginal fringe short. Ovipositor notably short and often no more than one-third the length of abdomen, and originates posteriorly to the middle of abdomen.

Only one undescribed species has been found in Taiwan.

Geuns *Lathromeromyia* Girault

Lathromeromyia Girault, 1914. Zeits. Wiss. Insektenbiol 10 : 308. Type-species : *Lathromeromyia perminuta* Girault. Original designation. Pasoeroean, Java.

Lathromeromyia is a small genus, it descributed to Java, Cameroons and South Africa. The characteristic structure can be recognized by the presence of antennal club 4-segmented, lacking funicle segment, annellus small, shape of forewing similar to the subgenus *Zorontogramma* of *Oligosita* by having marginal vein distinctly longer than premarginal vein, Forewing blade with sparse cilia, lacking vein track RS_1.

Two undescribed species have been discovered in Taiwan.

Genus *Giraultiola* Nowicki

Giraultiola Nowicki, 1936. Zeit. angew. Ent. Berlin 23 : 136. Type-species : *Brachysticha fidiae* Ashmead. Original designation. Euclid, Ohio, U. S. A.

Giraultia Steffan, 1954. Bull. Mus. Hist. Nat. Paris 26 : 669. (Lapsus for *Giraultiola* Nowicki).

Only the type species of this genus was known. This genus can be recognized by the presence of club of antenna 4-segmented, without an annellus and funicle. Forewing with distinctly rounded and broadened apex, vein tracks more or less present but lacking RS_1.

Only one undescribed species has been discovered in Taiwan.

Genus *Trichogrammatoidea* Girault

Trichogrammatoidea Girault, 1911. Trans. Amer. Ent. Soc. 37 : 13-15. Type-species : *Chaetosticha* (sic) *nana* Zehntner. Original designation. Java.

Trichogrammatoidea is a large genus and worldwide distributed. Its habits are resembled to *Trichogramma*. The characteristic structures can be recognized by the presence of the 3-segmented male club, long stigmal vein, absence of vein track RS_1 and the moderately long marginal fringe those are distinctly separated to *Trichogramma*.

There are 2 species recorded from Taiwan, *T. nana* attacked the eggs of *Chilo infuscatellus*, *Eucosma schistaceana* and *Diatraea venosata*, and *T. bactrae* parasitized the eggs of *Eucosma* sp. on sugarcane.

Genus *Trichogramma* Westwood

Trichogramma Westwood, 1833. Phil. Man. 2 : 444. Type-species : *Trichogramma evanescens* Westwood. Monotypic. England.

Calleptiles Haliday, 1833. Ent. Mag. 1 : 340. Type-species : (*Calleptiles latipennis* Haliday. Monotypic) =*Trichogramma evanescens* Westwood.

Pentarthron Packard, 1872. Rec. Amer. Ent. 1871 : 8. Type-species : *Trichogramma minuta* Riley. Monotypic.

Aprobosca Westwood, 1878. Trans. Linn. Soc. London, Zool. 1 : 592. Type-species : *Trichogramma* (*Aprobosca*) *erosicornis* Westwood. Monotypic.

Oophthora Aurivillius, 1898. Ent. Tidskr. 18 : 250. Type-species : (*Oophthora semblidis* Aurivillius. Monobasic)=*Trichogramma evanescens* Westwood.

Xanthoatomus Ashmead, 1904. Mem. Carnegie Mus. 1 : 360. Type-species : *Xanthoatomus albipes* Ashmead. Original designation.

Neotrichogramma Girault, 1911. Trans. Amer. Ent. Soc. 37 : 38-39. Type-species : *Neotrichogramma acutiventre* Girault. Original designaion.

Trichogrammatana Girault, 1932. New lower Hymenoptera from Australia and India : 1. (Privately published). Type-species : *Trichogamma* (*Trichogrammatana*) *singularis* Grault. Monotypic.

Trichogramma is large and worldwide distributed genus, expecially common in Holarctic region and parasitized the eggs of most Lepidoptera which are important pests of the agriculture and forestry. Some species have been used as the biological control agents of the major pests in different parts of the world.

Body short compact, forewing venation has often been platly sigmoid because the distal curvature at the end of the marginal vein onto the stigmal vein does form a shallow "S" with the curved premarginal vein. forewing broadly rounded with distinct vein tracks. Female with solid club obliquely truncate distally, fumicle 2-segmented; the male club elongate and irregularly surfaced with whorls of setae which are distinguishable from *Trichogrammatoidea*.

Trichogramma australicum Girault, *T. chilonis* Ishii, *T. dendrolimi* Mats. and *T. japonicum* Ashmead have often been discovered in this island which parasitized the eggs of the major pests mostly of the Lepidoptera attacking rice plant , sugarcane, forest, etc.

Genus ***Probrachista*** Viggiani

Probrachista Viggiani, 1968. Proc. Calif. Acad. Sci. 4 ser. 35(20) : 521. Type-species : *Probrachitsa nepalensis* Viggiani. Original designation. Taplejung District, Sangu, Nepal.

Only one species of *Probrachista* has been found in type locality. The characteristic structures of this genus can be recognized by the presence of the genal suture present, maxillary palpus with only 1 segment, antenna with either scape or pedicel elongate, with 1 small annellus, 2 cylindrical funicle segments are distinctly separatted, and with 2 elongate club. Forewing elongate, basally narrow and apically rounded. venation distinctly short, marginal vein long and straight, stigmal vein short, the disc with abundant microtrichia and the marginal fringe are short.

Only one undescribed species has been found in Taiwan.

Genus ***Eutrichogramma*** Lin, gen. nov

Type-species : *Eutrichogramma elongatum* Lin, sp. nov. Present designation.

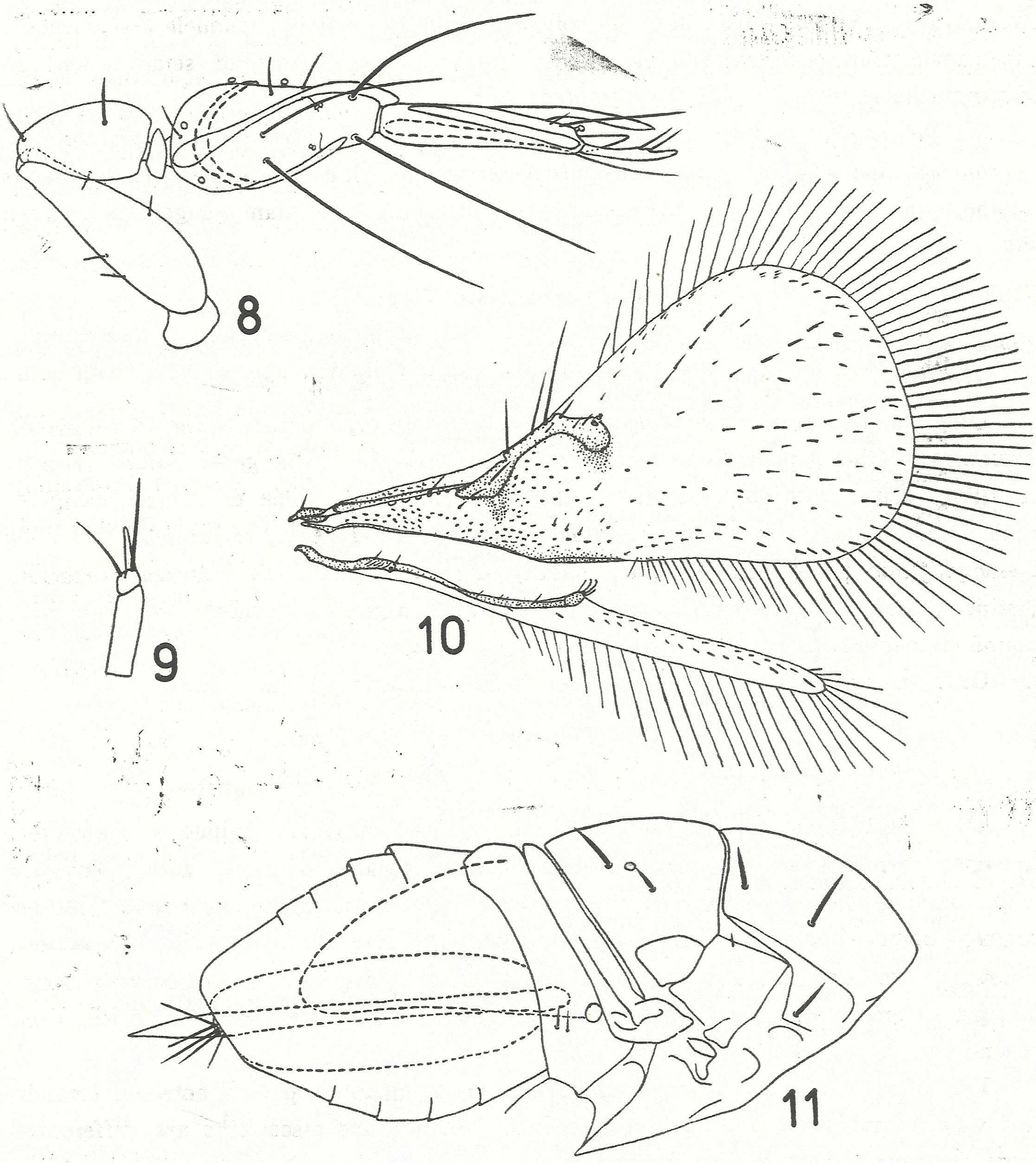
Body stout. Head normal, lacking genal suture; maxillary palpus 2 segments; antennal formula with a single annellus, lacking funicle segment, with 2 elongate club, basal segment broad basally, with whorls linear sensoria and long setae, second segment narrow and cylindrical, with linear sensoria and an apical long projection. Forewing broadened apically, marginal fringe long, marginal vein moderately long, straight, stigmal vein broad, discal cilia sparse, vein tracks RS_1 and base of RS_2, r-m, M and Cu_1 inconspicuous. Ovipositor long.

This genus can be recognized by the characters of maxillary palpus, antennal formula and with its appendix, the form of forewing, venation and discal cilia are differented from the other genera of Trichogrammatidae.

Eutrichogramma elongatum Lin, sp. nov.
(Figs. 8-11)

Female. Brown-black, eyes reddish, antennal scape and 2 basal tarsal segments lighter, wing hyaline, basal portion of forewing and beneath pterostigma infuscate, venation brownish.

Head shorter than wide in frontal view (0.8x), suboblated; eyes moderately large,



Figs. 8-11. *Eutrichogramma elongatum* gen. et sp. nov., female. 8, antenna ; 9, maxillary palpus ; 10, wings ; 11, body in lateral view.

sparse cilia; lateral ocellus lying close to eye, its interspace less than ocellar diameter; malar space about 0.6x as long as high of eye, genal suture absent; mandible with 3 very sharped outer teeth and the inner one broad and truncate; maxillary palpus 2-segmented, basal one about 4x as long as apical segment, apical segment distinctly narrow; labial palpus with a single segment which is short but little longer than wide; antenna inserted at level of lower margin of eye; scape reaching to median ocellus with apical portion distinctly narrow; pedicel about 0.6x as long as scape; annellus with single segment; funicle segment absent; club 2 segments, club I distinctly broaded basally, with 2 whorls linear sensoria and long setae on median and apical section, club II very narrow and delicate, slightly shorter than club I, with 2 linear sensoria, apical part with a distinct process.

Thorax compact, pronotum very short and declivous anteriorly; mesoscutum moderately convex, longer than scutellum (1.3x), scutellum weakly convex, both with longitudinal reticular sculptures and 2 setae on laterally; metanotum short, propodeum slightly long, both are nearly smooth; mesopostphragma reaching the 3/4 of abdomen.

Forewing about 2x as long as wide, broadened apically, venation extending midlength of wing blade; submarginal vein longer than marginal vein; premarginal vein slightly shorter than marginal vein, subtriangular and stout, radial process present; marginal vein straight and with 3 setae, stigmal vein broad, as long as marginal vein; pterostigma rounded; disc with sparse cilia, vein tracks R, RS_2, r-m, M, Cu_1 and Cu_2 are present, vein track RS_1 absent, marginal fringe long, less than 1/2 of greatest width of wing blade; hingwing very narrow, with 2 rows of cilia on disc, marginal fringe about 1/5 in wing length.

Legs moderately long and hairy, hind coxae distinctly longer than other, outer surface with uniseriate longitudinal microgranularity.

Abdomen as long as thorax, smooth, slightly point posteriorly, ovipositor long, from base of abdomen and exserted apically.

Length of body 0.8 mm., forewing 0.9 mm.

Male. Unknown.

Holotype. ♀ (#13658) TAIWAN Central, Kukuan, 730 m, Taichung Hsien, 20-22. VI. 1978. K. S. Lin and K. C. Chou.

Genus ***Aphelinoidea*** Girault

Aphelinoidea Girault, 1911. Trans. Amer. Ent. Soc. 37 : 2-4. Type-species : *Aphelinoidea semifuscipennis* Girault. Original designation. Centralia, Illinois.

Krygeriola Nowicki, 1934. Polsk. Pismo Ent. 12 : 3-4. Type-species : *Krygeriola dolichoptera* Nowicki. Original designation.

Lengerkeniola Nowicki, 1946. Zbl. Ges. Geb. Ent. 1 : 45. Type-species : *Lathromeroides (Lengerkeniola) bischoffi* Nowicki. Original designation.

Tanygramma De Santis, 1957. Notas del Museo, La Plata Univ. 19 : 37-38. Type-species : *Tanygramma xiphias* De Santis. Original designation.

Aphelinoidea is a large genus and worldwide distributed. The characteristic

structures of this genus by the presence of the antennal funicle segment absent and with 2 club segments broadly fused which resemble a spindle. Forewing elongate and rounded apically, disc with short abundant microtrichiae, vein tracks indistinct, the venation short, marginal vein broad and shorter than submarginal vein and stigmal vein very short.

Only one undescribed species has been discovered in Taiwan which is slightly abundant on the grass.

Genus ***Oligosita*** Walker

Oligosita Walker, 1851. Ann. Mag. Nat. Hist. (2) 7 : 212-213. Type-species : *Oligosita collina* Walker. Monotypic. Ireland.

Westwoodella Ashmead, 1904. Mem. Carnegie Mus. 1 : 359. Type-species : *Oligosita subfasciata* Westwood. Original designation.

Paroligosita Kurdjumov, 1911. Rev. Russe d'Ent. 11 : 434. Type-species : *Paroligosita bella* Kurdjumov. Original designation.

Pseudoligosita Girault, 1913. Mem. Queensl. Mus. 2 : 104. Type-species : *Pseudoligosita arnoldi* Girault. Original designation.

This genus is a very large, abundant and cosmopolitan. The characteristic structures by the presence of the antennal formula with a single annellus, a single elongate funicle and an elongate 3-segmented club frequently terminating in a rod-like projection. Forewing are narrowly rounded and wing disc is somewhat nearly devoid cilia, and marginal fringe are frequently very long.

In Taiwan, 5 species have often been discovered at lowland on the grass, weeds and rice field. Two abundant species parasitized the eggs of *Nephotettix cincticeps* which attacked rice plant.

Genus ***Epoligosita*** Girault

Paroligosita Girault and Dodd, 1915. Mem. Queensl. Mus. 3 : 145. Type-species : *Paroligosita biclavata* Girault and Dodd. Original designation.

Epoligosita Girault, 1916. Mem. Queensl. Mus. 5 : 206. New name of *Paroligosita* Girault and Dodd.

Epoligosita is a small genus, 2 species are described, and distributed in Queensland and South Africa. The characteristic structures by the presence of the forewing are almond shaped, disc cilia entirely absent, marginal fringe long, with long venation reaching beyond the midlength of wing blade, and marginal vein long and straight. Antenna with short scape, a single small annellus, a single funicle segment and club with 1 or 2 segments.

One undescribed species has been discovered in Taiwan.

Genus ***Megaphragma*** Timberlake

Megaphragma Timberlake, 1924. Proc. Hawaii. Ent. Soc. 5 : 413. Type-species : *Megaphragma mymaripenne* Timberlake. Original designation. Oahu, Hawaii.

Sethosiella Kryger, 1932. Bull. R. Soc. Ent. Egypte 1932 : 38. Type-species : *Sethosiella priesneri*

Kryger. Original designation. Tanta, Egypt.

Megaphragma are known to distributed comprising Hawaii, U. S. A., Haiti, Egypt, Zaire and South Africa. Three species have been described and each has been found associated with thrips.

The characters of this genus by the presence of the forewing distinctly narrow, peculiarly shaped as a plattened sigmoid with marginal fringe on both wings are very long; body is small in size, distinctly broadened; the antenna with a single annellus, a single funicle and 2 club segments.

One undescribed species has been reared from the eggs of *Empoasca formosana* Paoli, Cicadellidae on tea plant, *Thea sinensis* in Taiwan which antenna lacking funicle segment, club with 3-segmented, the basal one broadly and obliquely fused with club II, forewing discal cilia absent and body about 0.22 mm. in length.

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References

Doutt, R. L. and G. Viggiani. 1968. The classification of the Trichogrammatidae (Hymenoptera: Chalcidoidea). Proc. Calif. Acad. Sci . 4 Ser. 35(20) : 477-586.

Girault, A. A. 1911a. Descriptions of nine new genera of the chalcidoid family Trichogrammatidae. Trans. Amer. Ent. Soc. 37 : 1-42.

1911b. Synonymic and descriptive notes on the chalcidoid family Trichogrammatidae with descriptions of new species. Ibid. :42-83.

1912. Australian Hymenoptera Chalcidoidea-I. Mem. Queensl. Mus. 1 : 66-116.

1913. Australian Hymenoptera Chalcidoidea-I. Supplement. op. cit. 2 : 101-106.

1915. Australian Hymenoptera Chalcidoidea-I. Second supplement. op. cit. 3 : 142-153.

Ishii, T. 1938. Descriptions of two new Trichogrammatidae from Japan. Kontyu 12 : 179-180.

1941. The species of *Trichogramma* in Japan with description of two new species. op. cit. 14(5-6) : 169-176.

Kryger, J. P. 1918. The European Trichogramminae. Ent. Medd. 12 : 257-354.

Lin, Kwei-shui. 1974. Notes on some natural enemies of *Nephotettix cincticeps* (Uhler) and *Nilaparvata lugens* (Stal) in Taiwan. Jour. Taiwan Agric. Res. 23(2) : 91-115. (In Chinese with English summary)

Nagaraja, H. 1978. Studies on *Trichogrammatoidea* (Hymenoptera: Trichogrammatidae). Orient. Ins. 12(4) : 489-530.

Nikol'skaya, M. N. 1952. Chalcids of the fauna of the USSR (Chalcidoidea). Opred. Fauna SSSR. 44 : 1-575, 592 figs. Moscow (In Russian)

Nowicki, S. 1935. Descriptions of new genera and species of the family Trichogrammidae (Hymenoptera: Chalcidoidea) from the Palearctic Region, with notes-I. Zeitsc. angew. Ent. Berlin 21 : 566-596.

1936. Descriptions of new genera and species of the family Trichogrammidae (Hymenoptera: Chalcidoidea) from the Palearctic Region, with notes-II. op. cit. 23 : 114-148.

1940. Descriptions of new genera and species of the family Trichogrammidae (Hymenoptera: Chalcidoidea) from the Palearctic Region, with notes-Supplement. op. cit. 26 : 624-663.

Peck, O., Z. Boucek and A. Hoffer. 1964. Keys to the Chacidoidea of Czechoslovakia (Insecta: Hymenoptera). Mem. Ent. Soc. Can. 34: 1-122.

Sonan, J. 1944. Investigations on the parasitic Hymenoptera and its hosts in Taiwan. Bull. Govern. Agric. Res. Inst. Formosa 222: 30-31.

Viggiani, G. 1968. The significance of the male genitalia in the Trichogrammatidae. Proc. 13th Int. Congr. Ent. 1: 313-315.

1971. Ricerche sugli Hymenoptera Chalcidoidea XXVIII. Studie morfologico comparativo dell'arture genitale esterma maschile dei Trichogrammatidae. Boll. Lab. Ent. Agraria Portici 29: 181-222.

臺灣毛小蜂科之分屬及 2 新屬新種之記載[1]

林 珪 瑞[2]

中文摘要

本文依據大部分以掃網採得之毛小蜂科 (Trichogrammatidae) 製作 7,000 餘玻片標本進行鏡檢分屬，共有 22 屬，其中包括臺灣已記錄者 4 屬 *Paracentrobia* Hwd., *Trichogrammatoidea* Grlt., *Trichogramma* West. 及 *Oligosita* Grlt.；臺灣新記錄 16 屬 *Ufens* Grlt., *Mirufens* Grlt., *Poropoea* Frst., *Ophioneurus* Rtbg., *Lathromeroidea* Grlt., *Lathromeris* Frst., *Hispidophila* Vigg., *Haeckeliania* Grlt., *Chaetostrichia* Wlk., *Uscana* Grlt., *Lathromeromyia* Grlt., *Giraultiola* Nwk., *Probrachista* Vigg., *Aphelinoidea* Grlt., *Epoligosita* Grlt. 及 *Megaphragma* Tblk.；及 2 新屬、新種 (*Prochaetostricha monticola* 及 *Eutrichogramma elongatum*) 之記載並附形態特徵圖，臺灣毛小蜂分屬檢索表及各屬特徵記載等以供查考。

1. 臺灣省農業試驗所 研究報告 第 1022 號。

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